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ELECTRICAL WORLD

AUG 19 1935

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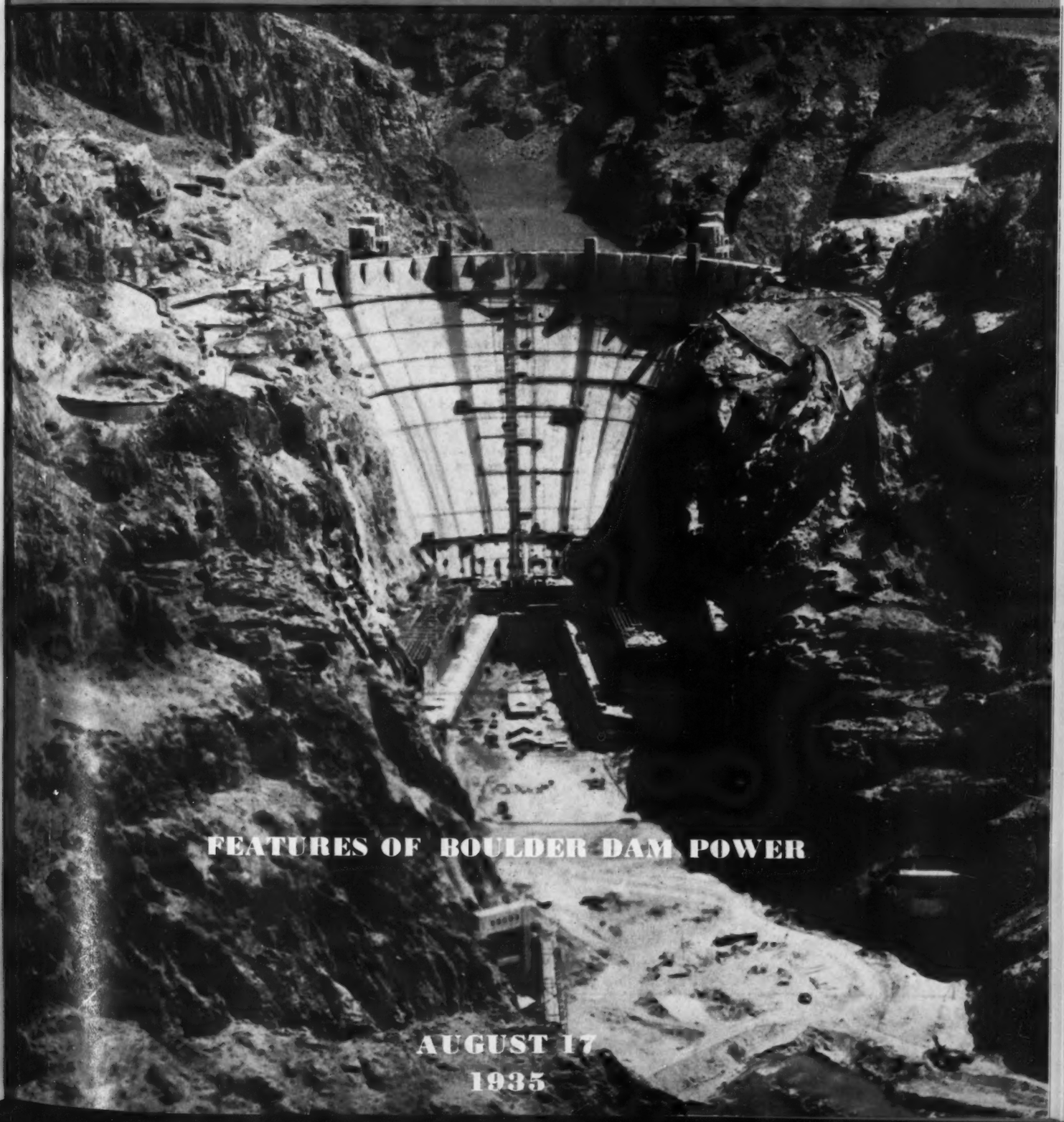
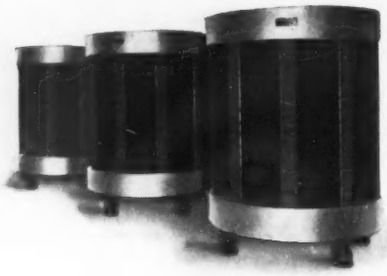


FEATURES OF BOULDER DAM POWER

AUGUST 17
1935



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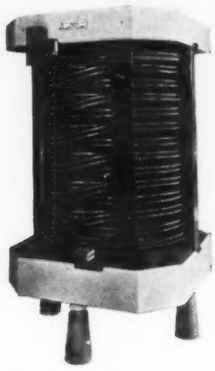
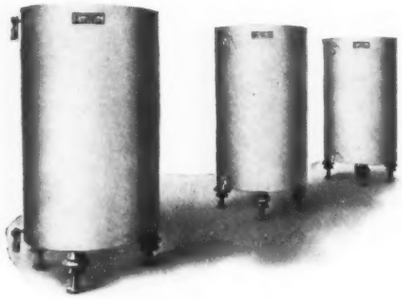
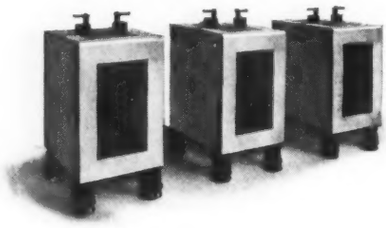
Special fuse testing reactor. Maximum short time rating 3000 Ampere, 12 K.V., 60 cycle, 6 tap variable reactance.



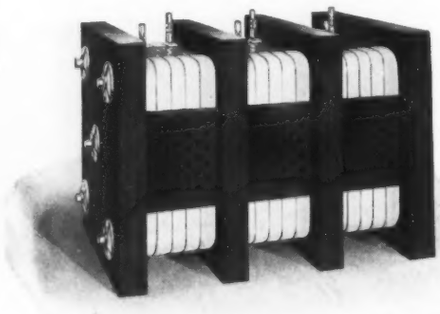
1125 K.V.A., 3000 Ampere, 12 K.V., 60 cycle indoor service, open type, fireproof construction, special design to meet customer's space allotment.



277 K.V.A., 600 Ampere, 16 K.V., 50 cycle outdoor service, dry type, all enclosed reactors.



162 K.V.A., 500 Ampere, 6.6 K.V., 25 cycle indoor service, enclosed type, fireproof construction.



36 K.V.A., 100 Ampere, 4.15 K.V., 60 cycle, 3 phase indoor service, enclosed type, fireproof construction.

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ELECTRICAL WORLD

FOUNDED IN 1874 • READ BY ELECTRICAL MEN FOR SIXTY YEARS

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VOLUME 105 . . . NUMBER 17

Contents Copyrighted, 1935, by McGraw-Hill Publishing Company, Inc.

ELECTRICAL WORLD—Published every other Saturday. Price 25 cents a copy. Subscription rates: United States, Mexico, Central and South American countries, $4 a year; Canada, including duty, $5 a year; all other countries, $6 or 24 shillings, a year. Entered as second-class matter, January 20, 1907, at Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U.S.A.

Branch Offices: 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, Aldwych, London, W.C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C.

Printed by The Schweinler Press, N. Y.

McGRAW-HILL PUBLISHING COMPANY, INC.
330 West 42d Street, New York, N. Y.

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OKOLITE insulation is suitable for many classes of power cable: Station—Aerial—Underground—Submarine—Industrial. Its scope runs from a small control wire to a heavy generator lead—or a submarine power cable.

OKOLITE insulation is particularly adaptable for braided cables in wet ducts—or where there are high temperatures.

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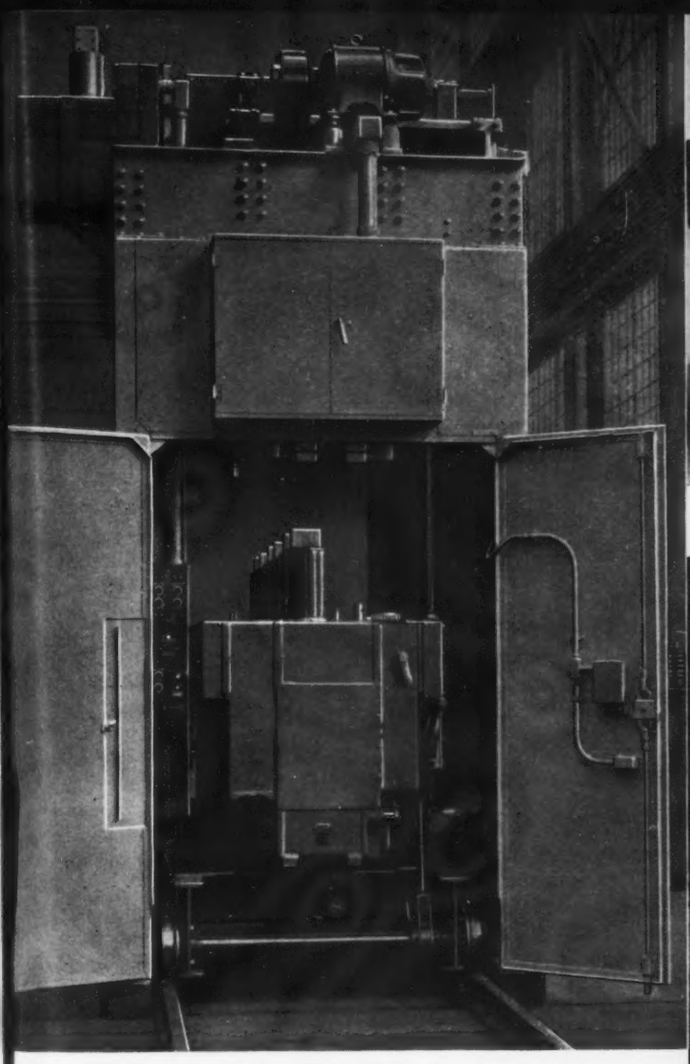
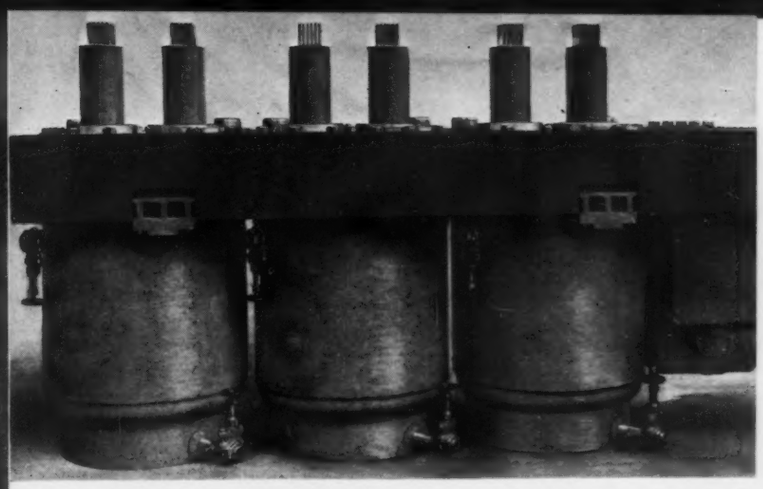




Left—Boulder Dam Metal-Clad Switchgear Unit, 4000-amp, 23,000-volt, 2,500,000-kva interrupting capacity. A circuit breaker is shown above.

Rotor and Stator of 40,000-kw, 257-rpm, 60-cycle, 13,800-volt Boulder Dam Generator.

Electrical Equipment for Boulder Dam Plant

THE switchgear unit shown above is one of the ten 4,000 ampere units for controlling all the power, at generator voltage, of the generators now being built for the Boulder Dam power plant. These circuit breakers are the largest of their kind in the world, having to interrupt 2,500,000 kva. at 16,500 volts, and in addition to the oil circuit breakers, shown above, include buses, disconnects, etc. These factory-built units, complete with all mechanical and electrical interlocks, are totally enclosed, with every safety feature yet conceived for switching equipment. For use with automatic synchronizing, these large breakers have exceptionally high speed closing . . . only 26 cycles time from impulse to control until the breaker is closed; direct motor operated. The Allis-Chalmers Expulsion Port arc extinguishing principle is used for interruption. The overall operating time from the time the trip coil is energized to the time the circuit is interrupted is 8 cycles (60 cycle basis); arcing time is 2 cycles.

The 40,000 kva. generator built by Allis-Chalmers will operate at a speed of 257 rpm. The rotor construction is unique. It consists of welded plate steel sections mounted on a cast steel spider. The welded plate steel yoke is surrounded by an air housing connected with surface coolers through which cold water is circulated for removing heat from the circulating air. Before shipment the rotor will be tested at an overspeed of 455 rpm. in a special test pit. These generators will have unusually high stability, necessary because of the long transmission line.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, U.S.A.

LETTERS TO THE EDITOR

Cooke Comments on Rural Electrification

To the Editor of ELECTRICAL WORLD:

I appreciate very much your keen interest in our rural electrification program. We at R.E.A. think the industry would be interested in several comments of mine about rural electrification which follow. These statements were prepared for inclusion in an interview with me published in your issue of July 6, but were not used, due, as I understand, to your space limitations. We think they are of interest as helping to illuminate the origins and aims of our program:

The President, with his farm in New York State and his farm in Georgia, knows from his own experience and that of his neighbors how highly farmers prize electricity. He also knows the difficulties encountered by farmers in securing electric service, for on his Southern farm he found the only economical way to secure this service was to build his own rural line.

The President's Executive Order establishing the Rural Electrification Administration gave it a broad foundation. The R.E.A. is empowered to "initiate, formulate, administer and supervise a program of approved projects with respect to the generation, transmission and distribution of electric energy in rural areas."

The fact that the Rural Electrification Administration was established to enter virgin territory at present without electric service simplifies our problem. Having due regard to an equitable distribution of the funds as between states and within each state, it is our plan to cooperate with any and all agencies through which the legislative and administrative purpose can be carried out.

It is perhaps tiresome—especially to the urban-minded—to hear it constantly reiterated that agricultural life is of vital importance to national well-being. But such is the case. Electricity being one of the major contributions which can be made to rural well-being, it is a safe guess that in the not far distant future plans will be made for reaching not only the increment of territory which we now have in mind, but for vastly extending electrification into areas not now seeming to be feasible even to the optimistic.

The T.V.A. has shown how low electric rates, low appliance cost, low finance costs and public education can increase consumption and build valuable loads.

There is considerable evidence that the utility industry has begun to profit from this demonstration, for the T.V.A.'s neighbor, the Tennessee Electric Power Company, was selected by the industry for the Coffin Award for "one of the most, if not the most, remarkable sales increases in residential, commercial and industrial power in the history of the electrical industry." It is significant that promotional rates and an average rate cut of 28 per cent contributed to this achievement.

I am very grateful for your co-operation in presenting our plans to the industry. I feel sure that you personally and the ELECTRICAL WORLD will be of great help to us.

MORRIS L. COOKE,
Administrator,
Rural Electrification Administration.

•

Germany's Humanized Electric Service Symbol

To the Editor of ELECTRICAL WORLD:

As we read the article "Humanizing the Kilowatt" in a late issue of the ELECTRICAL WORLD we experienced the sentiments of the schoolboy who, having done his sums, notes, after an illegal wink of the eye, that his capable neighbor has reached the same result. At the same time, as American advertising

A "Juice Boy" parade at the Munich "Octoberfest"

people in the electrical field announce their "Reddy Kilowatt," we are glad to state that we, with our "Strommännchen," i.e., "juice-boy," have hit the same path.

The coincidence is striking and a proof that the tastes of the consumer on different continents have their laws which direct advertising similarly. We must, however, admit the world-wide power of the film, the influence of Mickey Mouse, Felix and other figures.

In the city of Cologne, since the early Middle Ages, a certain fairy tale has been popular of tiny dwarfs whose only aim was to help man's activities. This personification was the only one we have known of in this country. In general, the slogan "Electricity in any device" was predominant. It was a parallel to the American "Do it electrically." It seemed a good occasion to start a new "humanized symbol," when in June, 1934, the centrally directed advertising forces of the electrical industries, generating, appliance-building and contracting as well, were combined in one organization, the present Arbeitsgemeinschaft zur Förderung der Elektrowirtschaft.

The first task of this neutral center was the inspiration of four well-schemed and timed "propaganda waves" rushing over all Germany and reaching even to the smallest hamlet. These waves, with their technical and economic foundations, were launched under the new advertising symbol, the above-mentioned "Strommännchen." The symbol met with an almost instant approval on the part of electrical people, dealers and last, but not least, the consumer.

The outward appearance of our "humanized" kilowatt is derived from the plug. With a general motto "Let me in—and be your servant" it had a promising début and nowadays it works far and near. On the occasion of many carnivals held in some towns we have already heard of and seen striking "Strommännchen" costumes. This plug was put on two legs, fitted out with merry cheeks and humorous eyes—our "juice boy" was born.

H. L. MEYER,
Editor *Der Werbeleiter*,
Berlin.

•

Sectionalizing Fuses With Banked Transformers

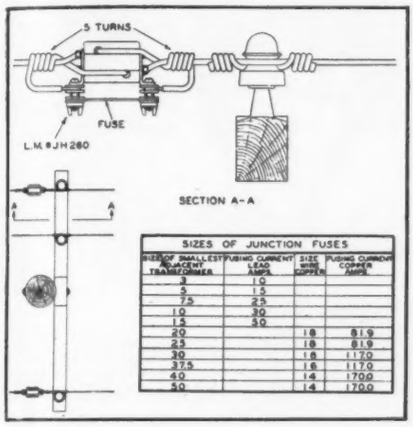
To the Editor of ELECTRICAL WORLD:

My article on "Distribution Service and Costs" in your March 16 issue has aroused some inquiries regarding the use of sectionalizing fuses with banked transformers referred to therein—fuse rating relative to adjacent transformers, method of installation and reliability. Possibly the same information may be of interest to a number of your readers.

The accompanying illustration shows the type of junction fuse we are now using and the table lists the fuse sizes installed between transformers. The strain insulators with the fuse clips mounted thereon were designed by our Mr. Hammack, and I believe are obtainable from the Line Material Company. Prior to this design we used two small copper terminals suspended below the

strain insulator. This type of assembly, we felt, was not as reliable as the new design, since the fuse was not held tightly enough, and the wind and movement of the wires would cause it to break. Owing to the fact that the fuse cannot be placed at the point of zero load, and since the point of zero load shifts from time to time, we do not claim that this system works perfectly.

It has been our practice to make a load test on all of our distribution transform-



Type of junction fuse now employed

ers during the winter peak, by means of a split-core current transformer and ammeter, and prior to the making of these tests we make an inspection of all the transformers and junctions on the feeder, to make certain that all equipment is functioning. During the inspection last fall we found between 15 and 20 per cent of the junction fuses had blown, but we do not feel that this number is sufficient to cause us to feel that the system is not functioning reasonably satisfactorily.

Several years ago we installed fuses of double normal rating on all of the transformers and junctions on two of our feeders. Only approximately 8 per cent of the junction fuses were found blown during our last inspection because of high fusing. Normally, we fuse 2,300-volt transformers at about 1 amp. per kva.

While we have not made any effort to keep detailed records of the number of cases where transformer outages occurred and where we have been able to render service by virtue of these fuses, I know such cases are quite frequent. Also, in the event of a transformer failure, it is usually possible to put a copper jumper around the fuse and carry the area that would be out of service until the transformer can be changed. Just what advantage we obtain in reduced transformer capacity necessary to supply our load as a result of banking is rather hard to determine, since we supply series lighting and three-phase power from the same feeders as lighting. However, in the city our ratio of demand to transformer capacity on the so-called lighting feeders, corrected for three-phase power, series lighting and losses, is about 0.75.

We do not apply the banking practice to transformers operating on 13-kv. circuits, because of the possibility of accident.

M. M. KOCH,
Superintendent Electric Distribution, Public Service Company of Colorado, Denver.

•

Storage Removes Restriction on Water-Pumping Demand

To the Editor of ELECTRICAL WORLD:

In the June 8 ELECTRICAL WORLD (page 28) there was a suggestion that water pumping be cultivated as a rural load builder. There is merit in classing water pumping with water heating. But to put water pumping in the same class as water heating (that is, to put it on the basis where it receives a low rate and where it will "earn" a low rate) it will be necessary to make sure that the water-pumping installation is well balanced between storage capacity and pumping capacity. The storage capacity should take care of a substantial part of the daily requirement, while the pumping capacity should be just large enough so that the pumping can be done on a more or less continuous basis, let us say in eighteen hours for the day of maximum requirement. Of course, again the argument for "off-peak" water pumping might be advanced. To my way of thinking to add "off-peak" water pumping to "off-peak" water heating is likely to act like a boomerang.

If the utility is successful in selling these two services the "off-peak" feature might be most embarrassing, since the capacity required for heating and pumping the water during a limited number of hours might readily require from 50 to 100 per cent of additional capacity in the distribution system.

Unrestricted water heating and water pumping in so far as time is concerned is desirable, but requires proper coordination of size of storage facilities and size of heating units and pumping capacity. If by this method we reach a point where additional distribution facilities are required on account of this load coming on top of a peak load on the distribution feeder such as lighting or cooking load we can then decide in each individual case whether it is more economical to install the additional distribution capacity or to install a device which would cut out the water heating and the water pumping during the peak period.

To make it unnecessary to install larger storage capacity for this purpose we can arrange it so that for water heating a heating element would cut in again during this period whenever the temperature dropped to, say, 110 deg., where normally during the rest of the day it would be held at 140 to 150 deg., and for water pumping arrange for a control device which instead of starting to pump whenever water is drawn from the tank would during this peak period cut in only when the amount of water in the tank had dropped down to a low predetermined level. This would reduce the amount of load during the peak period to a very moderate value and it would be found that most of this would start to come on only during the latter part of the peak period; that is, during the part when the peak load has started to taper off.

E. J. AMBERG,
Research Engineer, Connecticut Light & Power Co., Waterbury, Conn.

•

Taxes Soaring; Electricity Cheapening

To the Editor of ELECTRICAL WORLD:

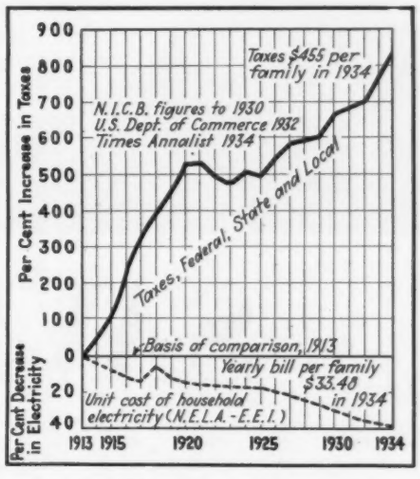
Inclosed are some startling figures in graphic form. You are respectfully urged to verify or disprove these figures. The writer believes you, too, will be astounded.

It is a fact that the cost of electricity is constantly coming down, whereas the cost of government is climbing at an alarming rate.

Why is Washington so concerned about the consumer of electricity? Is it to divert attention from the much higher and mounting cost of government?

In 1913 the per family taxes—federal, state and local—was $48.80, in 1934 $455 per year.

The average family electric bill in



Taxes per family *up* 830 per cent; cost of electricity *down* 38 per cent

1934 was $33.48, the same amount of electricity in 1913 would have cost $54.20.

Since 1913 the cost of electricity is *down* 38 per cent, cost of government is *up* 830 per cent.

Let us face the real issue.

CARL L. GERHARDT,
Westfield, N. J.

SAVE equipment, real estate, buildings, taxes, distribution feeders.

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MANAGEMENT • ENGINEERING • OPERATION • UTILIZATION
PUBLISHED EVERY OTHER SATURDAY

AUGUST 17, 1935

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A Landmark in Engineering

BOULDER DAM is more than the world's greatest power undertaking. It is a monument to engineering. For it was made possible only through the competency of our engineers, supplemented by the great organizations which manufacture equipment in this country.

This development dwarfs all others in scope and magnitude. But more than this, it represents the most modern ideas in design, in construction and in manufacture as applied to power supply. It introduced new methods, it brought solutions to new problems, it was characterized by new and improved equipment.

Large scale construction at its peak was had at the dam. The cooling of the concrete, the design of the dam, the welded pipes, the power equipment used in construction—all advanced the art enormously and gave experience and knowledge whereby dam building can go forward more rapidly and more economically in the future.

AT THE power house we find the largest units and latest designs in waterwheel generators and their accessory equipment. The use of hollow square busbars from generator to transformer in completely inclosed copper cubicles represents a new practice. Detail features of switches, controls, metering and auxiliary power supply represent new ideas and new apparatus. Even the air-conditioned generating room is in conformity with the modernity of this station. Here is a concentration of hydro-power in space and in equipment that is unparalleled and points the way to further advances.

But the dam and power house by no means embrace all the engineering features of the project. This power is taken to the loads nearly 250 miles away over 287-kv. transmission lines that represent advances in engineering of great moment. A new design of conductor, the use of extraordinary protective features such as the double counterpoise, the new design of tower, the enormous disconnect switches, the transformers, the new high-speed breakers, the equipment to control and regulate the line—all these things represent new and outstanding engineering feats. It is probable that this line and its equipment conform to the maximum economic limits in power transmission using open air shielded tower lines.

IT TAKES courage to depart from beaten paths in engineering. In some instances this was not necessary in the Boulder project, but the attitude of all connected with the work was to encourage the use of something new and improved, something that gave promise of better or more economical performance.

Thus, this project is not an example of conservative and traditional engineering. It represents the constructive daring of engineers who venture millions of dollars on new ideas and new designs. This is the type of action that brings about progress in this country. There may have been some mistakes in the details. Experience only will tell. But for magnitude and for innovations in the art this project exceeds any of record.

An attempt to appraise the economic aspects of this vast undertaking is a waste of time. There are too many factors. There is no agreed-upon basis for mixing irrigation, flood control, power, water supply and public welfare in an economic equation. Measurement of values must wait for future developments. But all can see and note the engineering features of the project and the utmost praise is due all concerned for the accomplishment of the world's outstanding feat in engineering.

This installation is a typical example of the attitude, the ingenuity and the genius of engineers that have made this country lead the world in power supply. Boulder was built upon and made possible by the lessons and experiences of the past. It affords the foundations for engineers to go forward to new triumphs.

·TRENDS·

Business Conditions Promising

THE electrical industry faces the fall with a promising outlook for improved business. Utility loads are mounting steadily and reports from all sections indicate that power use is on a wide basis, with a promise for a steady increase in industrial, commercial and domestic use. Local relations of utilities are vastly improved and the major political cloud only hovers over the industry in Washington. Electrical manufacturers have had good business for the past six months and the prospect is for even better business this fall. All types of products are in growing demand, the price situation is stable and competitive conditions are quite sound. Encouraging progress is being made in the sale of heavier power equipment, and this will augment the very large business being done in electric appliances. So far as business gages can be used to indicate the future the electrical industry finds the outlook promising in the coming months.

Move to Automatic Operation

INCREASED business for utilities and for industries is creating a demand for automatic operations of electrical and other equipment. This eliminates the variable human element and very frequently makes operation possible because skilled labor is not available. One of the first places to use the automatic principle is in power substations. The automatic substation is perfected and ready to go to work. But there are many other applications. We believe it will pay the utilities and industrials to study the present automatic equipment available in the electrical industry. It will cut costs and improve production.

Financing at Low Rate

REFUNDING financial operations of utilities have amounted to some $450,000,000 this year, with negotiations still active. The low interest rate has been the magnet to attract this business and general opinion prevails that this is about the bottom of the market as regards rate of interest. In fact, some investors are proving reluctant to take refunding bonds of certain enterprises, but as yet utility bonds are in investor demand. Wise utility managements, however, should act at once on refunding operations, because financial conditions often change quickly. Incidentally, endowed universities and trust funds are suffering from the decreased interest rates on bonds. Such is the effect of any shift in financial rates—some gain and some lose.

Transmission of the Future

ANY one who reads about the Boulder project will immediately dream about the future. It is a marvel of engineering, but it raises questions. For example, that enormous and expensive transmission structure surely is not the final word in power tranmission, although it represents the best in current practice. Some way must be found to reduce the costs, the space factor, the elaborate protection features, the insulation to a more logical answer to the transmission problem. Perhaps the underground pipe line idea will be the answer. Perhaps a very high-voltage d.c. line will be the answer. At all events, the imagination and ingenuity of engineers should be put to work to see if something cannot be done with regard to present practices in bulk power transmission.

Power-Factor Correction Moving

THE contemporary issue of *Electrical Contracting* says gangs and trucks of General Electric Service Corporation are going out in Harrisburg, Pa., loaded with equipment for power-factor correction. That is going to be more common news as loads creep up on unsuspecting capacities. Synchronous condensers and capacitors are no longer biding their time; they now get their chance to "put in capacity to conserve capacity."

Energy Output at Peak

A STEADY rise in output of energy since May is the best indicator of business volume available. Output now exceeds last year's winter peak and is 6 per cent greater than in the record year of 1929. Undoubtedly the coming winter will find an all-time record in peak value and in monthly output. Many properties will be stressed to supply the load. It is advisable to dust off the power station plans because generating capacity cannot be put into operation under a year and a half. Also, it is time to check substation capacity. Manufacturers are not ready to supply immediate deliveries of electrical power equipment in volume and precautions should be taken to obviate a famine for apparatus this winter and next spring. The gage for action is the energy output. It responds instantly to industrial demands.

Canal Zone as a Yardstick

IN THE Panama Canal Zone the government needs power for the operation of locks, towing ships, lighting and various other purposes. It sells to the inhabitants some of the energy generated in the hydro and Diesel stations. Here, if anywhere, the much publicized yardstick rates ought to prevail. The place ought to be a paradise for electrical customers. But in this part of his domain Uncle Sam hasn't heard of the yardstick, advocated with such enthusiastic ballyhoo at home. The dear old gentleman is either grievously overcharging his customers in the tropics, or, if he is selling at a reasonable rate there, his spokesmen in the happy valley are proclaiming, as standards for public utilities, rates that he himself cannot live up to, by a wide margin. The Panama schedule calls for 4 cents per unit for the first 150 kw.-hr. monthly, 2½ cents for the next 14,850 kw.-hr., 2 cents for the excess. The minimum bill is $1. Promiscuous rate comparisons are odious, but a big staff at Washington has turned out 48

The Editors Use a Spotlight on Current Happenings

state rate reports which are just that. So, the consumer of 50 kw.-hr. in the Canal Zone pays $2; if the T.V.A. rate is fair he ought to pay only $1.50, and the government is overcharging him 33 1/3 per cent. The 200-kw.-hr. customer pays $7.25, as against $4.50. That is an increase of 61 per cent. For 400 kw.-hr. the bills are respectively $12.25 and $6.50; the excess on the isthmus is 88 per cent. According to the government's own practice elsewhere, the T.V.A. rates are fantastically too low. But it would ill serve the purposes of politicians to have this generally known. The Panama yardstick will not be flourished in the propaganda sheets.

World Power Conference

THE President and the Secretary of State have recommended to Congress an appropriation of $75,000 for expenses of a World Power Conference in this country in 1936. Frank R. McNinch, chairman of the Federal Power Commission, attended the International Executive Council of the World Power Conference at The Hague in July. The two events go together. But one wonders. Will this be a non-partisan conference, such as was held at Berlin, or a governmental-sponsored propaganda meeting for public ownership, yardsticks and other New Deal pets? A worth-while world power conference should and can be held in this country, but the program for this conference should be developed by a non-partisan committee of experienced power engineers and executives.

Another Semi-Annual Sales Study

LOOKING back across the years, it is amazing to see the scale on which the power companies are selling nowadays. At present it is concentrated largely in the domestic field. But it is a symptom of profound change, and as general business swells in volume, the same increased activity will be seen in building commercial and industrial load. Meanwhile home appliance merchandising is worth watching. So in our next issue the sales of more than 100 companies for the first half of the year will be analyzed in another comprehensive tabulation.

Joint Power With Industrials

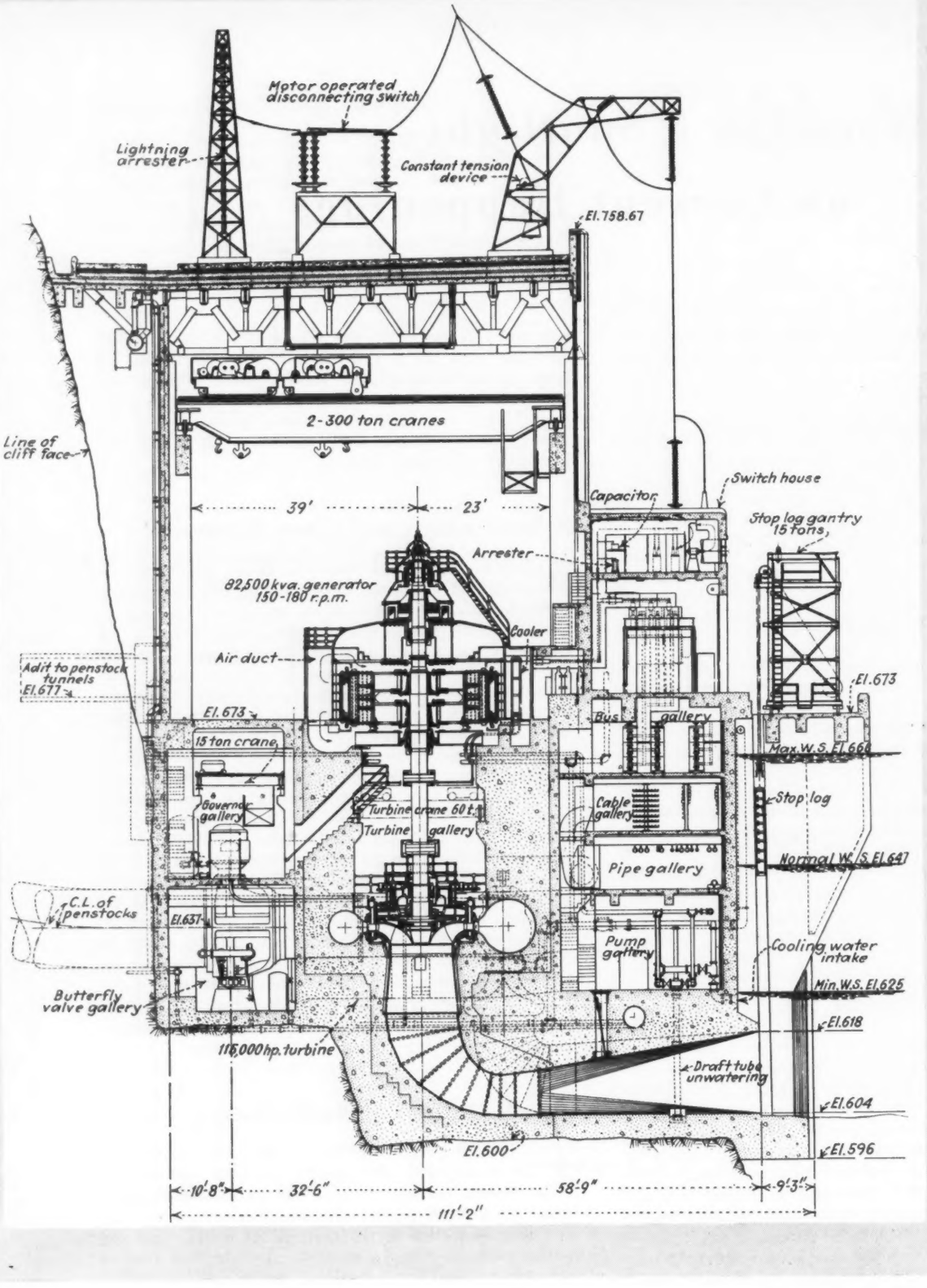
A REVIVAL of business in heavy industry is creating a lively interest in power. These industries are studying the possibilities of making their own power, of buying power or of putting in a portion of their power needs and then operating in parallel with utilities. Some utilities will operate in parallel with industrial plants, but some will not. This latter policy is unwise as a generalization. The proper practice comes from a factual study in each case and very frequently the answer will involve parallel operation with the utility. This is particularly true in large industries using some steam. Many of these are unserved now by utilities and the joint operation principle is ripe for application to the increased need for power that is found in these industries. It will benefit both parties in many instances.

A New Culture and a New Economy

ALL WILL agree with Morris L. Cooke, who stated recently that the introduction of electricity to the farm would bring about a new culture and a new economy in rural life. Undoubtedly electricity has raised urban life to a higher scale of comfort and convenience than is found on the farm. The relative cultural levels have changed because of electricity. All wish that rural electrification was an accomplished fact. But grant that cultural improvement is wholly desirable, the major question is whether rural electrification can be sustained on a sound economic basis. All city dwellers would like to have complete electric homes, but they cannot afford it. All farmers would like to have complete mechanized farm equipment. But these things are not practicable under present conditions. The cost is more than the capacity to pay. And this cost is not only the cost of power or of lines. The major item is the cost of equipment and wiring on the farm to use electricity fully and freely. With an average farm income of about $525 a year this is not possible. From an economic point of view there must be a slow development in rural electrification. It is a project that necessitates a vastly increased economic status for farmers. Idealism and sympathy run up against these facts in rural electrification.

Results Attest the Work Done

THIS country has about 25,000,000 electric customers. This is approximately equal to the total customers in Great Britain, Germany, France and Italy. Private enterprise has brought electrification to this country in a scope and magnitude that is the envy of the world. But the public takes this feat for granted. And the New Dealers say this accomplishment was an act of God instead of being built from the initiative and brains of electrical men. Political enemies criticise the results and seek to stifle men who can and will exceed the records of the past in bringing prosperity and increased comforts to this country through a greater electrification. This is the statesmanship that now dominates this country with respect to electrical policies. These men say "let us take over this electrical business" without regard for public interest, the facts or their competency to run it. They will not succeed. They are rapidly coming to a reckoning with the public.



WELL-PLANNED DESIGN CHARACTERIZES BOULDER PLANT

Note the layout in the power house roof, including the counterweight tension device on outgoing circuit. Section through an 82,500-kva. unit in the Nevada wing.

Colorado Power and Water

Hydrology of the Colorado River Shows Potentiality for Irrigation and Flood Control to Be Paid for by Power Revenue—Unusual Construction Features of Boulder Dam—Forced Cooling of Concrete

FAR-REACHING results may be expected from the completion of the Boulder Canyon project on the Colorado River. This stream has long been recognized as a tremendous potential source of power and water, the U.S. Bureau of Reclamation having completed several plans for its development as early as 1924. Aside from the importance of power generation and irrigation, a primary objective of the Colorado Basin improvements is flood control to protect the rich farming areas around Yuma, Ariz., and the Imperial Valley, which have suffered severely from the frequent large floods for which the Colorado River is noted.

Any development of the Colorado River must take cognizance of the demands and needs of diverse communities and interests which may be summarized as follows:

1. Flood control for the lower river basin.

2. Storage in the reservoir of silt, which before had filled canals and ditches of irrigated lands.

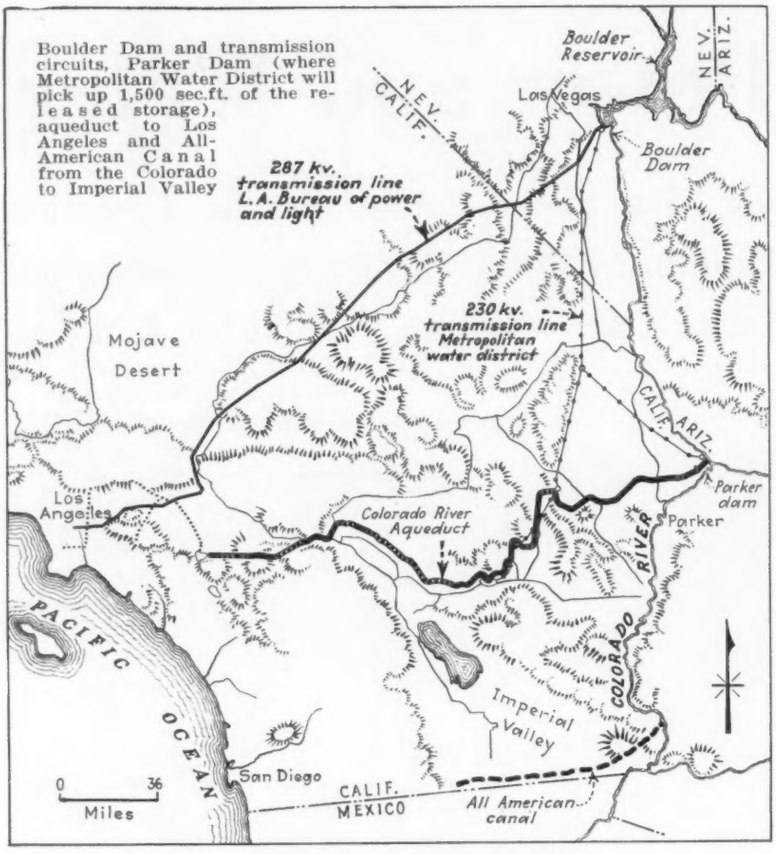
3. Adequate storage of flood waters to provide a reliable source of irrigating water for possible later development of new farming areas in southern Arizona and California and to provide ample water for the Yuma project and the Imperial Valley through the All-American Canal, which is included as part of the project. By maintaining a specified minimum flow, navigation also will be improved in the lower river.

4. Provide additional water from the storage for domestic use in the southern California metropolitan areas and perhaps for certain irrigation districts there.

5. Generate power from the release of stored waters, which power could be made available for users in Arizona, California and Nevada and the revenues from which would make this project self-liquidating.

After exhaustive surveys of the Colorado River Basin, the upper Black Canyon site, approximately 30 miles southeast of Las Vegas, N. M., seemed best fitted to fulfill the above requirements. Here a dam approximately 730 ft. high would impound some 30,000,000 acre-ft. of water in a storage reservoir from which irrigation and domestic water supply could be obtained economically and in sufficient quantities to supply the foregoing needs.

On December 21, 1928, Congress passed the Boulder Canyon Act authorizing the expenditure of $165,000,000 for the project. Of this amount, $70,600,000 was for the dam and reservoir, $38,200,000 for the power plant, $38,500,000 for the All-American Canal, a project approximately 250 miles below the dam proper, which will deliver 15,000 sec.-ft. of water from the lower Colorado to the Imperial Valley, and $17,700,000 for interest charges until all construction charges are repaid by the sale of power. Closely identified with and made possible by Boulder Dam is the $220,000,000 Metropolitan Water District project, which is now approximately 40 per cent completed and which will pick up 1,500 sec.-ft. of Colorado River water released from the Boulder reservoir for domestic purposes in California at Parker Dam, approximately 150 miles below Boulder Dam. By means of a system of canals, conduits, reservoirs and pumping plants, the district will


Boulder Dam and transmission circuits, Parker Dam (where Metropolitan Water District will pick up 1,500 sec.ft. of the released storage), aqueduct to Los Angeles and All-American Canal from the Colorado to Imperial Valley
Boulder Reservoir
NEV. ARIZ.
NEV. CALIF.
Las Vegas
Boulder Dam
287 kv. transmission line L. A. Bureau of power and light
230 kv. transmission line Metropolitan water district
Mojave Desert
CALIF. ARIZ.
Parker dam
Los Angeles
Colorado River Aqueduct
Parker
COLORADO RIVER
PACIFIC OCEAN
Imperial Valley
San Diego
CALIF. MEXICO
All American canal
0 36 Miles

Three-fold project in Pacific Southwest

deliver this amount of water to the Los Angeles area, some 275 miles to the west.

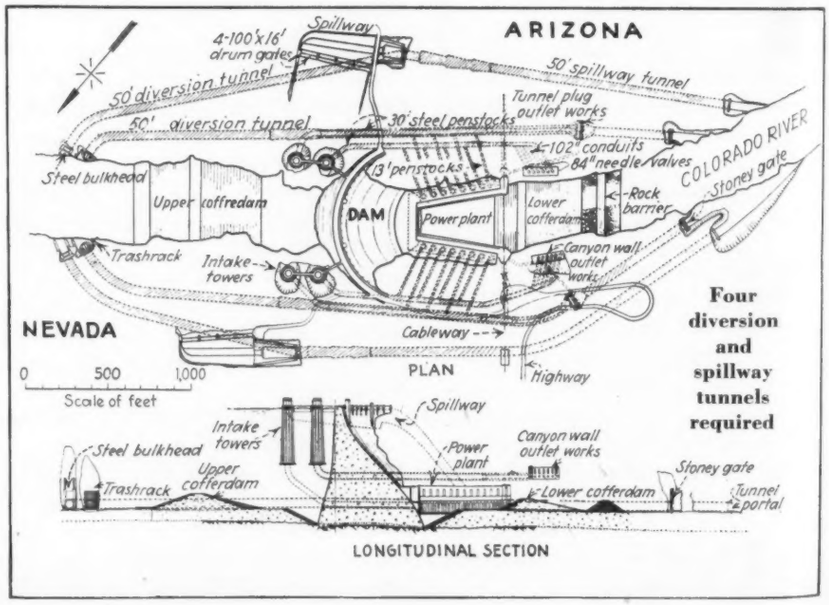
To appreciate the magnitude of the Boulder Canyon project, some knowledge of the Colorado River watershed is essential. This stream drains an area of 240,000 square miles in seven states. Stream gage records from 1902 to 1932 show an average annual flow of 15,700,000 acre-ft., the minimum and maximum flow during this period being 7,000,000 and 24,000,000 acre-ft., respectively. In 1934, however, the recorded flow was only 27 per cent of the average. Characteristics of the Colorado River are its tremendous run-off, suddenness of severe floods and high silt content of its waters.

The site selected for Boulder Dam is at the upper end of Black Canyon, a deep narrow gorge with sides of andesite and with bedrock at a depth of approximately 120 ft. below the riverbed. At this point has been erected an arch gravity-type dam, the highest in the world and creating the largest man-made lake in the world. The dam itself is 727 ft. high from foundation rock to crest, 1,180 ft. along the crest, 45 ft. through at the top and 650 ft. through at the base. Volume of the dam alone is 3,250,000 cu.yd. of concrete, weighing approximately 6,600,000 tons.

Numerous are the advance construction practices that were employed in the erection of the dam and appurtenances thereto. Of these probably the most important was the method developed to hasten the normal cooling rate of the setting of the concrete. To obviate a long period of grouting and to exercise the greatest possible precaution toward making the structure immediately and permanently safe, it was decided to facilitate the dissipation of setting heat by dividing the dam into a number of independent blocks, pouring these in definite stages in columns keyed together to form one compact mass when completed and to cool the entire structure by refrigeration to a point where there would be no sufficient temperature drop of sufficient magnitude to produce crack-forming strain.

It was computed that the amount of heat to be removed would be 965 B.t.u. per cubic yard of concrete for each degree that the structure was to be cooled. It was also computed that the heat generated by the setting concrete would be sufficient to raise the temperature of the structure some 40 deg., so that it was required to extract approximately 38,600 B.t.u. for each cubic yard in the 3,350,000 cu.yd. in the dam.

This was accomplished by a permanent installation of cooling pipes and headers in the concrete of the dam. Through these pipes precooled water from the river was first circulated, which removed as much as one-half of the required amount of heat. As the height of the column increased the cooling water headers were moved up to the next "pour" and refrigerated water from a 1,000-ton refrigerating plant circulated to bring the concrete mass down to the final temperature. In this way each column was progressively cooled by precooled river water and refrigerated water, so that when the dam was completed final



Four diversion and spillway tunnels required

grouting was possible with complete assurance that internal strains from heat could not disturb the monolithic quality of the entire structure of the dam.

Materials handled by cableway

Another interesting detail of construction is the 150-ton permanent cableway which is used to lower penstock sections to adits in the canyon walls, from which they can be moved through headers to their proper positions in the tunnels. Later the cableway will be used to facilitate the erection of equipment and apparatus in the power house. The cableway is arranged to pick up a standard railroad car with its load on a specially built cradle and deposit it on loading platforms at the south end of each wing of the power house, where the car can be rolled onto the tracks which pass the entire length of each wing at the elevation of the generating floor.

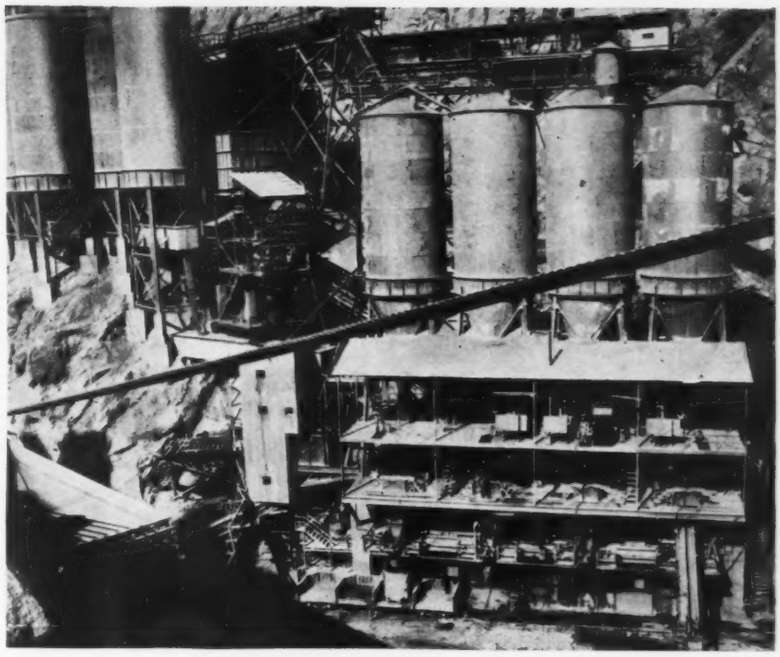
Forming now behind the dam is a reservoir which will eventually have a total capacity of 30,500,000 acre-ft. The dam will back the water up 115 miles, nearly to the mouth of the Grand Canyon of the Colorado, and the 550-mile shoreline of the lake thus formed is expected to open up a new recreational area that will be an ideal winter playground.

The reservoir capacity has been allocated as follows:

(a) 9,500,000 acre-ft. is to be reserved at all times for flood storage.

(b) 12,000,000 to 15,000,000 acre-ft. is reserved for active storage for power, generation, irrigation and domestic water supply.

(c) 5,000,000 to 8,000,000 acre-ft. reserve for a silt pocket, as it is estimated that the average volume of silt carried into the reservoir by the river will be equivalent to approximately 137 acre-ft. annually.



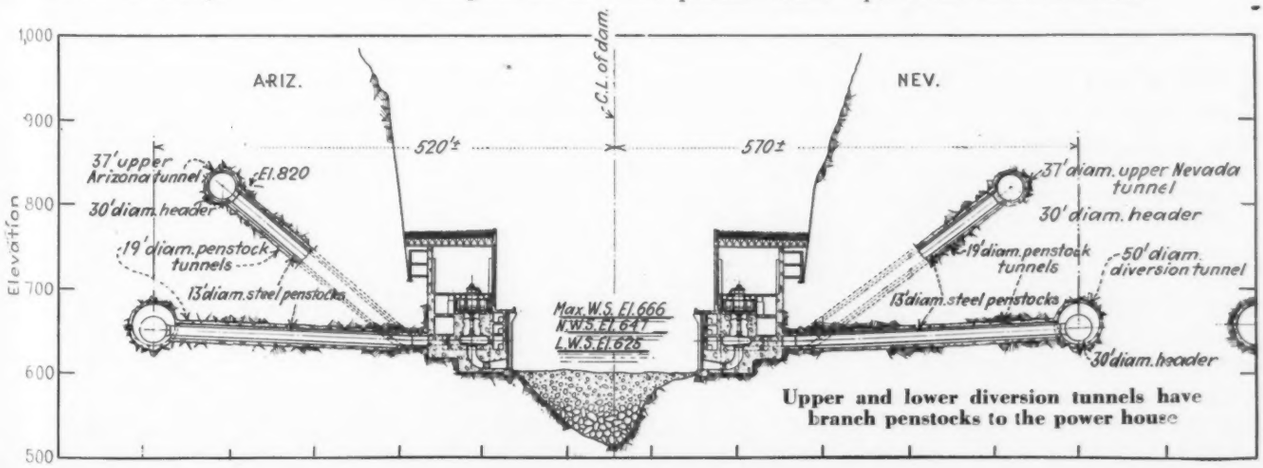
Concrete plant layout contributed much to the record-breaking speed at which the dam was poured

Aggregates and concrete enter the plant at the top and are mixed and deposited into the buckets on the car shown at the lower left. Concrete cars have four bays, two for full buckets and two for "empties." Buckets are picked up by cableways

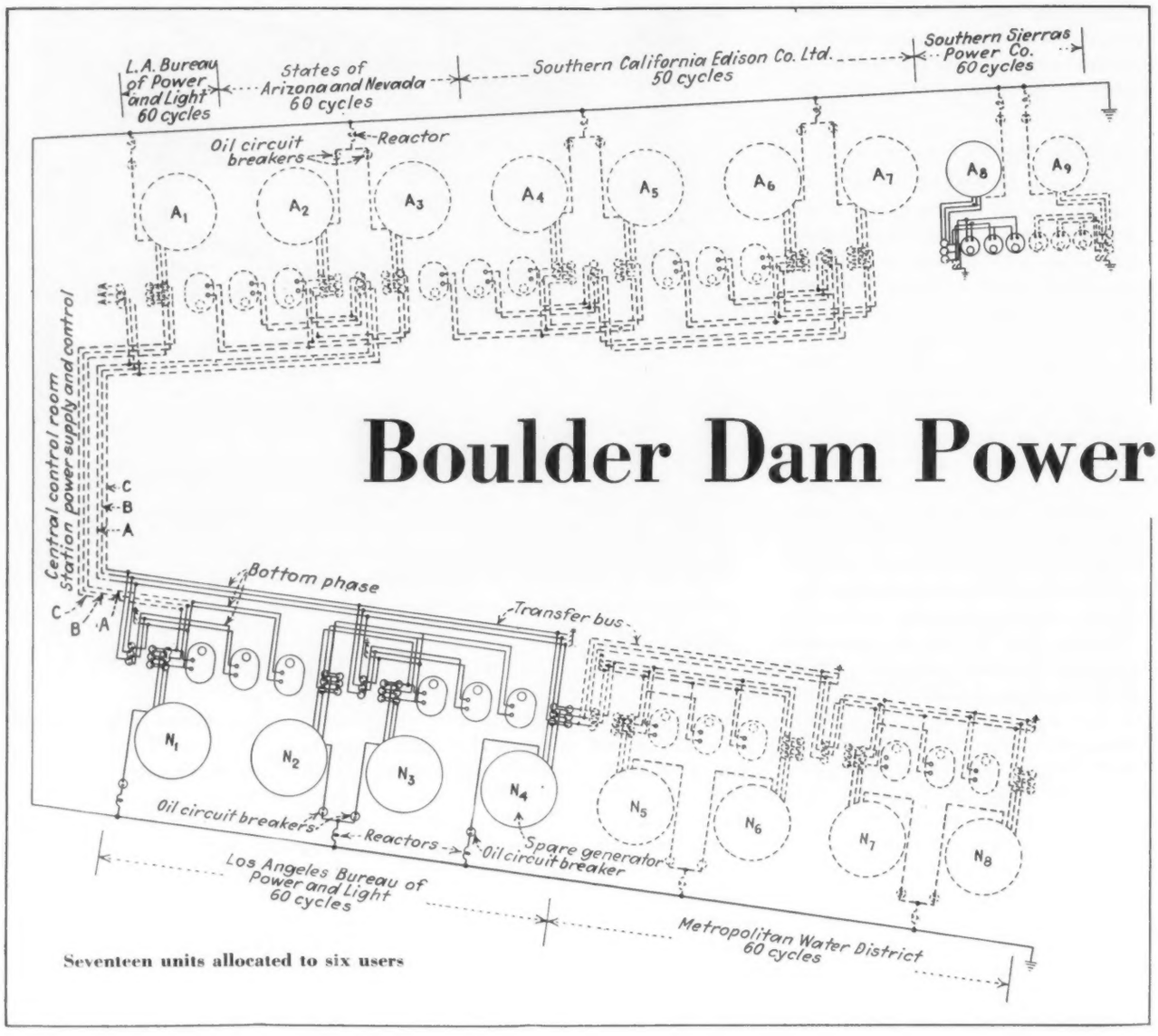
The release of the active storage over a year's time is expected to produce 4,330,000,000 kw.-hr. of firm power (equivalent to 665,000 continuous hp.) and 1,550,000,000 kw.-hr. of secondary energy, all of which is contracted for by various agencies. Firm power will be delivered at transmission voltage for 1.63 mills per kilowatt-hour. Secondary power is to be delivered for 0.5 mills per kilowatt-hour at transmission voltage.

Of the water thus released, based on a 16,000,000-acre-ft. flow, 4,400,000 acre-ft. has been allocated under the Colorado River compact to California, and the Boulder Canyon project authorized California, Arizona and Nevada to enter into an agreement whereby California's quota has been assigned to the Metropolitan Water District and to several irrigation projects.

The estimated average annual income from the project over a 50-year period will be $6,550,000 for firm power, $650,000 for secondary power and $250,000 from the sale of water. This gross income of $361,000,000 is expected to retire principal and interest of the original investment of $165,000,000, permit a sinking fund for depreciation, carry the current operating and maintenance expenses of the plant and set up a surplus of $166,500,000, which will be divided 62½ per cent to the United States, 18¾ per cent to Nevada and 18¾ per cent to Arizona. The government's share of the surplus will be used to retire flood control bonds and further improve the Colorado Basin.



Upper and lower diversion tunnels have branch penstocks to the power house



Seventeen units allocated to six users

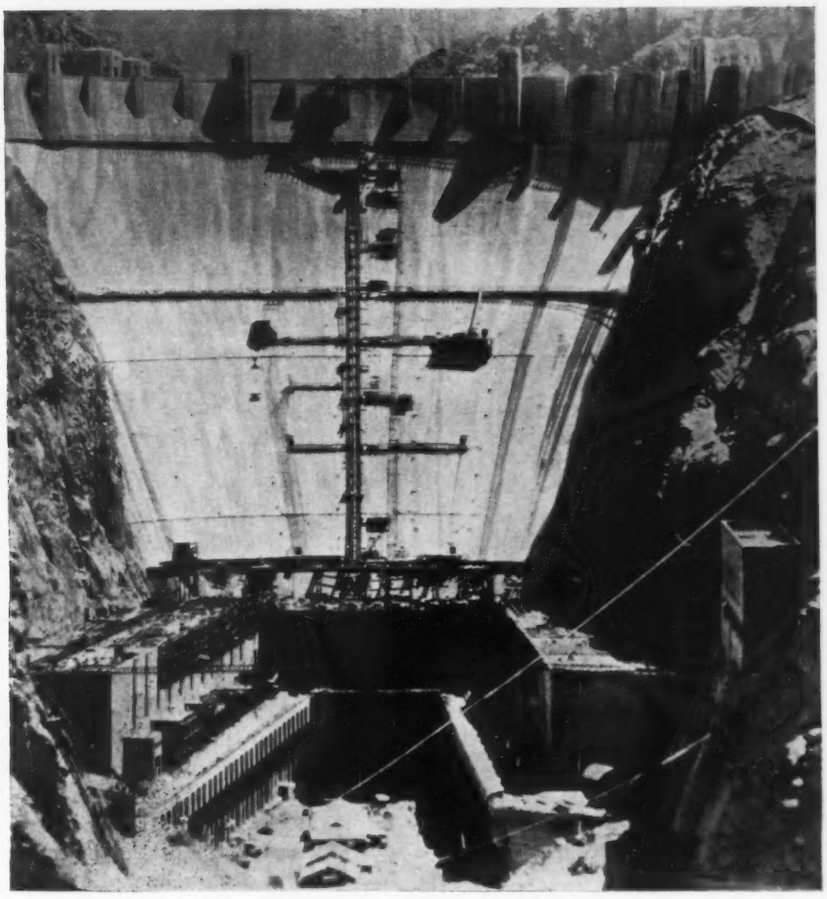
Boulder Dam Power

Unique Features Incorporated as to Stability Design, Governing, Synchronizing, Braking of Hydro Generators—Two Frequencies and Three Voltages Involved

IMMEDIATELY below the dam the power house is installed. This is a "U"-shaped structure, the central portion resting across the downstream toe of the dam with wings extending along either side of the canyon wall. In the two-wing sections are installed the generating units which make this structure the largest concentration of power-generating equipment in the world, the central portion being reserved for control and station service switchboards.

The power house is laid out and built for an ultimate of fifteen 82,500-kva. units and two 40,000-kva. units. Of these, four of the largest units are assigned to the Los Angeles Bureau of Power and Light, four to the Metropolitan Water District, four to the Southern California Edison Company, Ltd., one each to the two states of Arizona and Nevada and one for a spare, the two 40,000-kva. units being assigned to the Southern Sierras Power Company. The power house is unique in that all of the units will operate at 60 cycles except the four for the Southern California Edison Company, which will operate at 50.

For the initial installation four 82,500-kva. units and one 40,000-kva. unit are now in process of erection. The four large units will be installed in the upstream end of the Nevada wing of the power house, which wing will eventually contain a total of eight such units. The 40,000-kva. unit will be installed at the downstream end of the Arizona wing, which will eventually contain one more similar unit and seven 82,500-kva. units.



Two wings of power house placed in canyon at base of the mammoth dam

House

There are four intake towers, each 82 ft. in diameter at the base, immediately upstream from the dam. The upstream towers on either side of the river form the intake for the 30-ft. steel penstocks installed in the 50-ft. inner diversion tunnels at elevation 650. The two downstream intake towers on either side form the intake for the penstocks in the 37-ft. tunnels at elevation 820, which penstocks also are 30 ft. in diameter. Penstocks vary in thickness from $2\frac{3}{4}$ in. to $\frac{5}{8}$ in.

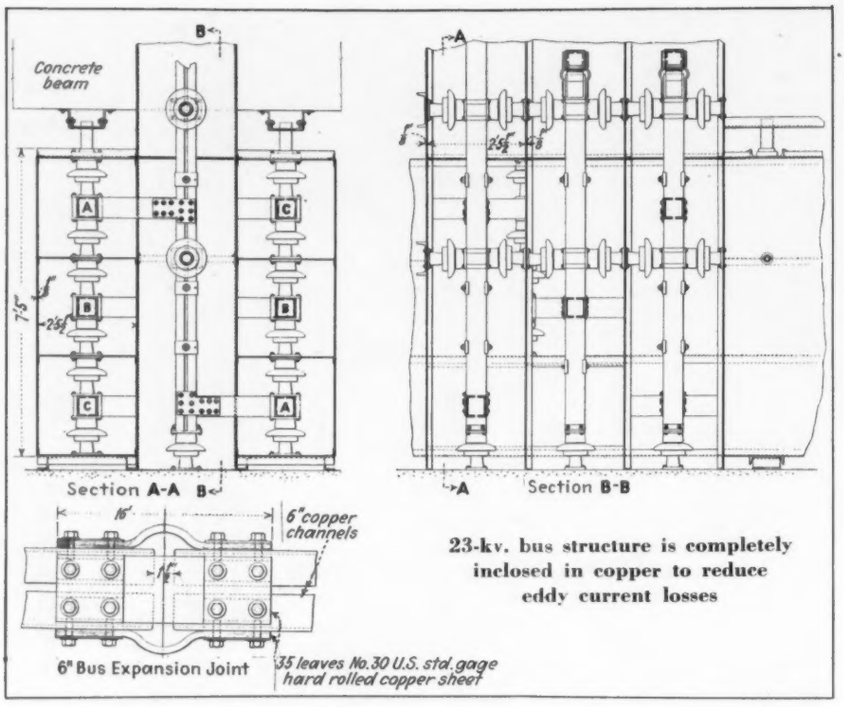
Each of the four 30-ft. main penstocks supplies water for four 13-ft. branch penstocks, each leading to an individual generating unit (one penstock dividing at its lower end for the two 40,000-kva. units), the two lower tunnels continuing into the downstream plug outlet works and the two upper penstocks terminating in canyon wall outlet works above and downstream from the power house proper. Each of the two plug outlet works contains six 72-in. and the canyon wall outlet works six 84-in. needle valves pointed downstream at an angle of 30 deg.

Spillways on either side of the canyon connect with the outer diversion tunnels on either side of the river, the connection being made by a 600-ft. sloping raise which varies in diameter from 100 to 50 ft. Each spillway consists of a concrete-lined open channel about 650 ft. long, 150 ft. wide and 120 ft. deep and is capable of handling 200,000 sec.-ft. The entire hydraulic installation, consisting of four main penstock tunnels and two diversion tunnels, is capable of passing a total of 525,000 sec.-ft. around the dam.

Generating units largest to date

As the 82,500-kva. units are essentially duplicates of the other only one need be described. In each generator bay of the larger units the 13-ft. branch penstock terminates in a butterfly valve 168 in. in diameter. These valves are designed to operate with no flow in the penstock and will not be closed until the turbine wicket gates are closed or opened until the pressure in the turbine scroll case and penstock has been equalized by two bypass connections (12 in. in diameter on the larger units and 8 in. on the two smaller units). However, they can be closed in an emergency condition under a maximum pressure of 300 lb. per square inch with an 8,000-sec.-ft. flow in the penstock. The valve will be operated by approximately 1,000-lb. oil pressure, the position of the leaf being continuously recorded by a "Selsyn" transmitter and also by red and green indicating lights, both of which are illuminated when the rotor is in motion. Control of the valve movement is so interlocked that movement cannot occur until pressures have been equalized on either side of the leaf or until the turbine wicket gates are in a closed position.

The turbine is of the vertical-shaft, single-runner, spiral-casing type with a Francis, cast-steel type runner. The four larger generating units of the initial installation are designed to operate at 60 cycles, 180 r.p.m. Turbines are designed to operate under a net effective head ranging from a minimum of 450 ft. to a maximum of 590 ft., the average being 530 ft. The design is such that the turbines operate at a maximum efficiency when working under heads between 510 and 530 ft. with an output of between 90,000 and 100,000 hp. The units discharge into a split draft tube in which provision is made for the introduction of compressed air to destroy any vacuum which might occur under certain operating conditions, and which also makes it possible to displace the tail-water so that with the wicket gates of the turbine closed the unit can be motored as a synchronous condenser on the



23-kv. bus structure is completely inclosed in copper to reduce eddy current losses

line with no water in the turbine casing.

Turbines are provided with wicket gates which, other than size, are of the conventional type both in construction and operation. A pressure regulator or relief valve, having a capacity of 80 per cent of the full-gate discharge of the turbine and not less than 80 per cent of the flow rejected by the turbine when full generator load is rejected from a part gate at 590-ft. head, is connected in the inlet to the scroll case and discharges into tailwater.

Double-winding generators

The generator to which the turbine is connected is of the vertical type, rated 82,500 kva., unity power factor, three-phase, 60 cycles, 16,500 volts and operates at 180 r.p.m. Its over-all diameter is 40 ft. and the over-all height above the generator floor line is 22 ft., each unit having a moment of inertia (WR^2) of 105,000,000 lb. at a radius of 1 ft.

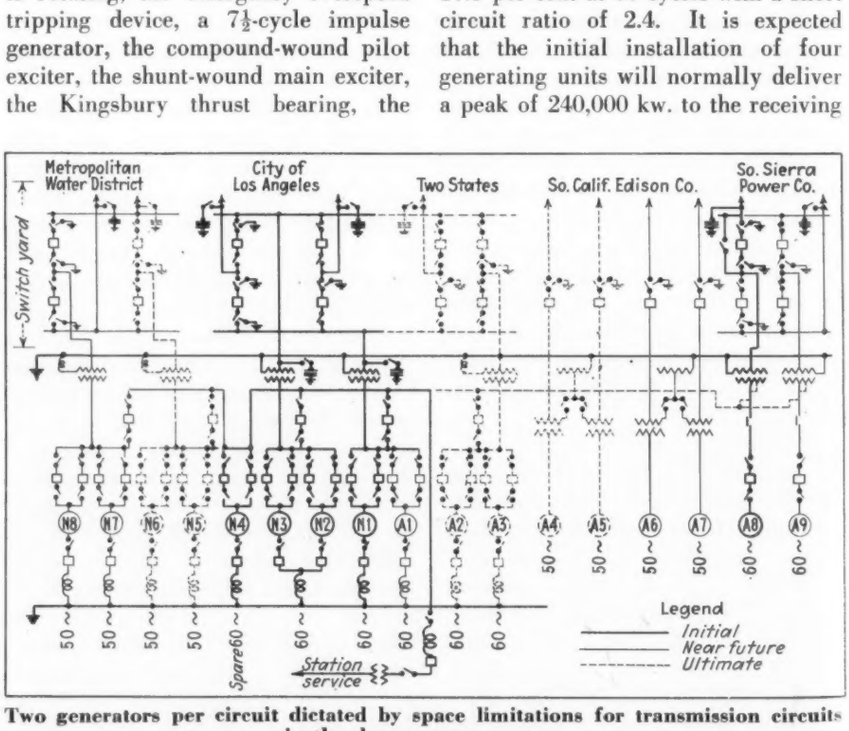
The stator winding is star-connected with two parallel circuits per phase, being suitable for operation grounded or ungrounded, as operating requirements may dictate. Insulation is of the class B type. The rotor is constructed of a cast-steel spider upon which a laminated rim is shrunk with the pole pieces dovetailed into the rim. The shaft consists of a 36-in. diameter steel forging with integral coupling flange having a 6-in. axial hole through the longitudinal axis. The rotor spider will be shrunk on the shaft and secured by a key against turning. The shaft is extended to support the armature of the direct-connected main exciter, the pilot exciter armature being mounted on a stub shaft bolted to the main exciter armature. As mounted on the vertical shaft from top to bottom, the rotor assembly consists of a dome pilot light to indicate whether or not the machine is rotating, the emergency overspeed tripping device, a 7½-cycle impulse generator, the compound-wound pilot exciter, the shunt-wound main exciter, the Kingsbury thrust bearing, the rotor and lower guide bearing. The thrust bearing supports the entire weight of the rotating mechanism, including the turbine runner, the complete assembly weighing approximately 900 tons.

Generators are provided with air-operated brakes having sufficient capacity to bring the rotating parts to a stop from half speed within 7½ minutes. The brakes are designed to be used as hydraulic jacks for raising the rotating parts off the thrust bearing, and a portable motor-operated, high-pressure oil pumping unit is provided for operating the jacks.

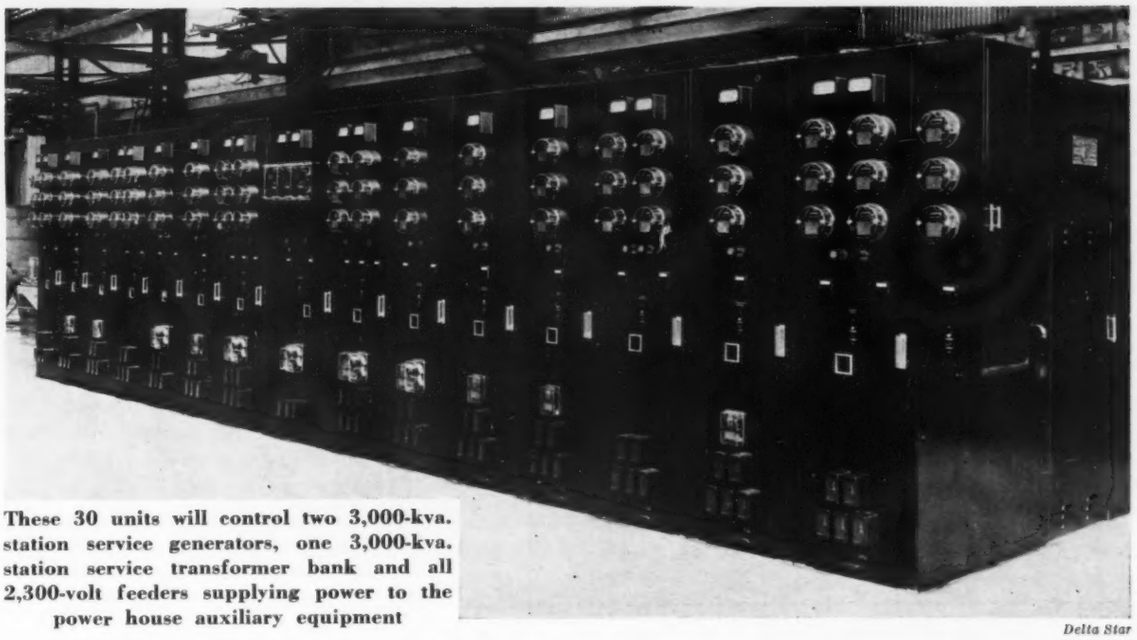
Excitation, stability and governing

With machines of this inertia the time constant is relatively long, so that the highest possible rates of excitation were not necessary and the exciter response has a value of 0.5 as defined by A.I.E.E. standards. Each generator is provided with an automatic voltage regulator of the non-vibrating reed type and arranged so that the unit may be operated independently of all the other units in the plant. The voltage regulator and excitation systems are capable of responding to voltage chanegs in a period of less than three cycles, which is the limit necessary for system stability and in which all switchings will occur.

The reactance of these generators is 17.5 per cent at 60 cycles with a short circuit ratio of 2.4. It is expected that the initial installation of four generating units will normally deliver a peak of 240,000 kw. to the receiving



Two generators per circuit dictated by space limitations for transmission circuits in the deep narrow canyon



These 30 units will control two 3,000-kva. station service generators, one 3,000-kva. station service transformer bank and all 2,300-volt feeders supplying power to the power house auxiliary equipment

Delta Star

stations in Los Angeles. However, the rating of the generators was selected as 82,500 kva. at unity power factor, the over-rating serving the purpose of both obtaining the low reactance which will improve stability and in providing an emergency standby capacity which would permit transmitting 300,000 kw. over the two circuits, although this is the upper limit of stability in case of a fault.

Although it does not affect the governor design appreciably, the high inertia of these machines substantially alters governor performance. The governors are of the oil-pressure, relay valve, actuator type which control the position of the turbine gates to oil pressure-operated "Servo" motors. The speed response element is electrically driven from a permanent magnet generator directly connected to the top end of the main generator shaft. This speed control generator operates at 7½ cycles and drives a 7½-cycle, synchronous motor, flyball mechanism which is sensitive to speed variations of less than 0.01 per cent. The governor auxiliary equipment is capable of completely closing or opening the turbine gates in five seconds when operating under full head.

Pre-set loading and automatic synchronizing

As the generating units are arranged to operate independently, a complete set of auxiliaries and control is necessary for each. Power-operated auxiliaries such as oil pumps, lubricating pumps and other devices are supplied from 460-volt station service through a 460-volt distribution panel located in the cable gallery. Each generating unit has an individual power distribution board for its auxiliaries. Control for the power circuits to the various auxiliaries, served from this board, however, is carried to the governor gallery above the butterfly valve gallery for convenience in operation. In the former are installed the turbine flow meters, governor, actuator and control boards for the unit auxiliaries which contain the push-button switches and indicating lights for the various auxiliary circuits.

Essential auxiliary units such as turbine guide bearing lubricating oil pumps, the generator guide bearing oil pumps, etc., are supplied in duplicate, one set being driven by a 460-volt, a.c. motor and the other by a 250-volt, d.c. motor, such duplicate units being arranged for automatic throwover to the d.c. source when trouble develops on the normal a.c. supply circuits.

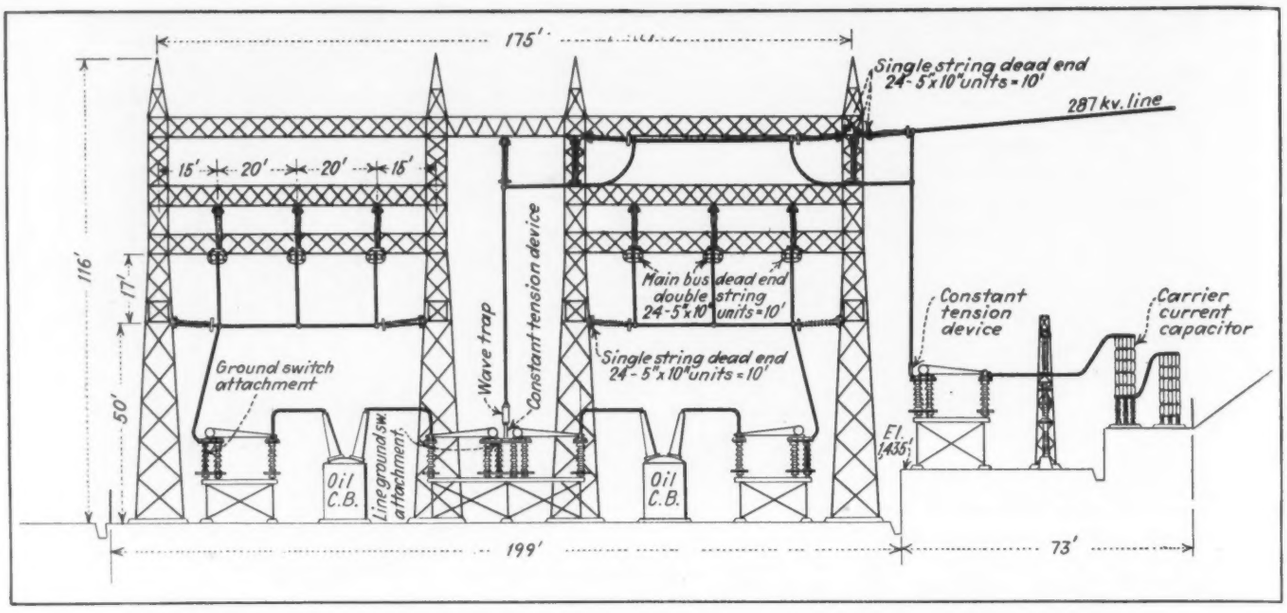
On a balcony along the front or river wall of the generating room and a few feet above its floor is installed a cubicle-type generator control board and a cubicle-type excitation board for each generating unit. Thereon is a complete set of controls from which the operator can bring the machine up to speed and synchronize it to the bus. A duplicate set of these controls also is provided on the central control miniature benchboard hereafter described. Normally, control will be retained at the central control benchboard.

A feature of the control installation is the pre-set load and automatic synchronizing possible from the control circuits. Remote control from either the central control switchboard or the generator cubicle provides for operation of the turbine wicket gates, load limit, speed droop characteristics and automatic synchronizing. Full automatic load and frequency control and automatic synchronizing are provided. The latter is obtained through an automatic, thermionic, speed-matching device mounted on the switchboard which controls the turbine speeds through the speed-adjusting motor on the governor.

Auxiliary plant layout

In the general plan of the power house the Nevada wing is laid out for eight 82,500-kva. units installed on 62.5-ft. centers and one station service generator. The four upstream units comprise the initial installation in this wing. The Arizona wing is laid out for seven 82,500-kva. units and two 40,000-kva. units and one station service unit. The latter and one 40,000-kva. unit are the only machines contemplated in the initial installation in this wing.

The central portion of the power house contains service equipment, station power transformers, 230- and 460-volt distribution switchboards, the direct-current power sources and central control equipment for the entire plant as well as the sumps for the entire power house and concentrates the seepage of water through the downstream part of the dam, Boulder City water pumps, air compressors for



Control of 287-kv. switchyard on the Nevada rim is by cable from power house operating room

the power house and machine shop equipment. A cross-section through the Nevada wing of the power house is shown that gives a clear conception of the excellent planning of this structure.

The bus gallery extends the entire length of each wing and across the central portion of the power house. Generally speaking, each phase of the main bus structure consists of two 6-in., "U"-shaped sections of copper clamped every 18 in. to form a hollow square busbar having a 4,000-amp. capacity. Bus supports consist of post-type insulators which permit the bus to be carried on the floor, walls or ceiling of the bus gallery and permits riser connections to be made in a manner identical with the main bus structure. The entire structure is completely inclosed by non-magnetic material for safety and reliability and is fully air-insulated between phases. The design will withstand the electrical and mechanical forces induced by a single-phase short circuit having an initial fully offset peak value of 274,000 amp. flowing in a phase and between two bus conductors.

The main bus structure for each generator is mounted generally in the half of the gallery nearest the machine, a transfer bus of similar construction being carried in the outer half along the entire Nevada wing across the central portion of the power house and downstream along the Arizona wing, terminating in front of the third large unit in that wing. This transfer bus permits a spare generating unit to be connected to any transformer bank served by the 60-cycle units. This gallery is air-cooled to remove the heat produced by electrical losses in the bus.

Because the high concentrations of current in the main power bus might induce sufficient current in surrounding metal to generate undesirable heating in such parts, each reinforcing bar in the concrete around the bus gallery was insulated from the others to increase the resistance of any current path. All conduit in proximity to the main power bus is of copper or brass for the same reason.

Unified power layout

In the initial installation two main generating units supply one bank of transformers through a double bus arrangement. While it is expected that this arrangement will prevail for all the machines in the Nevada wing, the arrangements for the Arizona generators have not been definitely decided upon. Each bank of main power transformers, of which there will be two initially on the Nevada side, supply an independent transmission circuit. Because of the plant's location in a deep, narrow canyon, the number of high-voltage circuits which can be brought out safely is limited, which dictated the use of two generating units per transmission circuit.

Power will be generated at 16,500 volts and transformed to 287.5 kv. for transmission to Los Angeles. A uniform arrangement of low-tension switching equipment and the transformer banks is provided for on each wing. A switch house for the low-tension circuit breakers for each generator is installed outside the main generating room. Between the individual switch houses are three bays. These bays, formed by the fire walls, each contains one 55,000-kva., water-cooled, 287.5-kv. Y to 16.5-kv., single-phase transformer. These three single-phase units comprise the bank served by the two adjacent generating units.

Transformers are of the circular-coil, shielded, non-resonating type designed to withstand an impulse voltage sufficient to flash over an 88-in. rod gap. The impedance is as low as practical, being approximately 10.75 per cent. The efficiency of each unit is 99.31 per cent. Electrically and physically, they are the largest transformers ever constructed, each transformer occupying a floor space 13x21 ft. with an over-all height of 32 ft. Each unit weighs 385,000 lb., of which 150,000 lb. is oil. Fire protection is provided by means of a water curtain above and in front of each transformer.

Generators are arranged for grounding from the neutral point of the stator windings through a circuit breaker and reactor which limits the ground fault current through the neutral to 10,000 amp. based upon a condition where three 82,500-kva. generators are connected to the 16.5-kv. bus and the feed back through two generators connected to their transformer bank and the 287-kv. bus. Relay pro-

tection for the entire main power system and connected apparatus, generally speaking, can be classified as the conventional differential relay system.

From the secondary (287 kv.) side of the transformers leads are carried to the roof of the power house structure and then up the side of the canyon wall to the switch yard on the Nevada side of the canyon. At this voltage it is necessary not only to provide adequate spacing between phases, but also between conductors and the wall of the canyon. Therefore, 90-ft. steel towers constructed at a 30-deg. angle with the vertical are placed on the canyon rim to insure a minimum of 30-ft. clearance between the wall and the conductors. One 287-kv. lightning arrester mounted on the power house roof is provided for each outgoing conductor.

Switching equipment consists of four 287-kv. oil circuit breakers, eight motor-operated disconnecting switches, six lightning arresters and the supporting steel structure for the 287-kv. double bus arrangement. The circuit breakers are of the dead tank type with six breaks per pole, each break being equipped with a deionizing arc-extinguishing device. They will interrupt 2,500,000 kva., operating in less than three cycles.

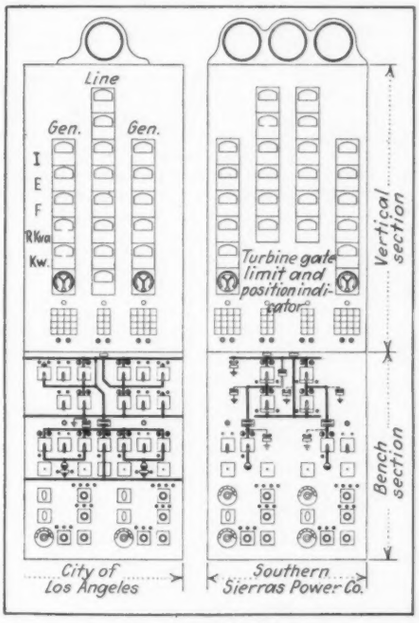
Control for the switchyard apparatus is centralized at the power house, the control circuits being carried on steel trays in a tunnel which is driven up through the canyon wall to the location of the switchyard control house on the canyon rim.

Control system centralized

In the main portion of the power house, connecting the two wings, centralized control for the main generating units and control of the power supply and circuits for the station service is provided. Cable galleries from both wings of the power house terminate here in riser shafts on either side of the central portion, the control cables and conduit runs being carried up this shaft to the cable racking room, where they are fanned out and their circuits carried up to the terminal room, just below the main switching center of the plant.

Centralized control for the main generating units is provided on a miniature benchboard. Here the chief dispatcher of the plant has complete control of the main units and the 287-kv. switchyard in so far as switching, loading and power allocation are concerned. Before generating units come under centralized control the machine operators on the turbine floor must have all auxiliaries for that particular unit in operation and the control transfer switch on the generator control cubicle must be set to transfer control to the main operating room.

Also in the central control room is a miniature benchboard for the complete control of all station power. Station power is provided from two 3,000-kva. units driven by impulse



Control for the five 82,500-kva. generating units centralized in 6-ft. miniature benchboard

turbines. One station power generator is located at the upstream end of each wing, the water being supplied for the turbines from a 36-in. penstock which is tapped in the two upstream 13-ft. penstocks at each end of the wing and which is carried across the central portion of the power house so that both generating units can be supplied from either or both ends. As a supplementary source of station power a transformer bank connected to the main 16.5-kv. bus is provided. Station power is generated at 2,300 volts and distributed through a 2,300-volt, metal-clad switchgear installation in the central portion of the power house. With the exception of the large sump pump motors at the lower gallery in each bay, all auxiliary equipment in the power house is operated either from 460-volt, a.c. circuits or from 250-volt, d.c. circuits.

Power for auxiliaries is obtained from two 2,300/460-volt transformer banks, each of which serves a 460-volt main power distribution board. This provides a symmetrical power layout, each power house wing being supplied from an individual transformer bank and distribution board. The main power distribution board supplies individual 460-volt circuits for each of the unit auxiliary power boards located at the generator positions. Similarly, through two more 600-kva. banks, station service power boards provide 460-volt power for cranes, compressors, power outlet receptacles and other uses in each wing, the symmetrical layout being followed for both the 460-volt systems.

D.c. supply in dual form

Two systems of direct-current supply are provided. For 250-volt direct-current power two 120-cell storage batteries are installed in the central portion of the power house. Three 250-volt motor-generator sets bused so that one set will float on the line with each battery, with one acting as a spare unit, are installed. A 60-cell battery and two 125-volt motor-generator sets provide 125-volt d.c. power for the station. All control in the plant is provided from direct-current power circuits. From the 250-volt d.c. mains power is obtained for standby motor-driven auxiliaries and for the solenoid operation of all switches, circuit breakers and contractors in the plant. The 125-volt direct current is used for indication and remote control through auxiliary relays.

Control for the station service power circuits is centralized on a miniature benchboard in the same room as the control board for the main generating units. A feature of its construction is the annunciator system by which the operation of unit auxiliaries for each generating unit can be checked at a glance.

Oil purifying equipment in the upper construction adit handles only the oil for the power house equipment. There is a complete oil purifying set located at the switchyard. This will be located in an underground room, thus allowing the oil from the high-tension oil circuit breakers to drain into the oil storage tanks by gravity. The oil will be pumped back into the oil circuit breakers after filtering.

Boulder power house is unique in that it will eventually generate power at two different frequencies for a number of independent utilities and will transmit at three or more voltages. A

[*Continued on page 45*]

Boulder Project Equipment—Rating and Manufacturer

Equipment or Feature	Number	Rating or Description	Manufacturer or Contractor
Intake Towers			
Concrete towers	4	384 ft. high, 75 ft. av. outside dia. reinf. concrete	Six Companies Inc.
Gates	8	Cylindrical, 32 ft. dia. 10 ft. high, welded steel	Westinghouse Elec. & Mfg. Co.
Entrance liners	48 sets	2,300,000 lb. of cast steel	Goslin-Birmingham Co.
Trashracks	48 sets	4x24 in. openings, 6,500,000 lb. of structural steel	Ingalls Iron Works
Bulkhead gates	2-sts. (24-gts.)	To close off gate openings and unwater tower	Bethlehem Steel Co.
Gate hoists	4	To operate cylindrical gates, 1 driving unit, 3 hoisting units per tower	Consolidated Steel Corp.
Revolving cranes	4	For lifting and lowering trashracks and bulkhead gates	Judson-Pacific Co.
Intake tower bridges	4 spans	Structural steel girders	McClintic-Marshall Corp
Penstock Header			
Header tunnels and adits	4	Two 50-ft. dia. (inner diversion tuns.), two 37-ft. dia. all concrete lined	Six Companies Inc.
Plate steel pipe	4,650 ft.	30 ft. dia. 111/16 to 2½ in. thickness, welded and pinned	The Babcock & Wilcox Co.
Penstocks			
Penstock tunnels and passageways	18	Sixteen 18-ft. dia. concrete lined, two 12.5 ft. dia. excavation concrete fill around pipes	Six Companies Inc.
Penstock pipe	5,800 ft.	(Approx.) 13 ft. dia. 1⅛ to 1 $\frac{5}{16}$" thickness, welded and pinned	The Babcock & Wilcox Co.
Penstock pipe	115 ft.	(Approx.) 9 ft. dia. 1½ in. thickness, welded and pinned	The Babcock & Wilcox Co.
Penstock pipe	900 ft.	(Approx.) 24 to 42 in. dia. flanged joints	The Babcock & Wilcox Co.
Outlets			
Outlet header tunnels	4	Continuation of penstock header tunnels	Six Companies Inc.
Outlet header pipe	1,900 ft.	25 ft. dia. to 20 ft. dia. 1⅜ to 2⅛ in. thickness, welded and pinned	The Babcock & Wilcox Co.
Outlet conduit tunnels	12	11x11 ft. horseshoe excavated, concrete fill around pipe	Six Companies Inc.
Outlet conduits	1,950 ft.	8½ in. dia. ⅜ to 9/16 in. thickness, welded and hot riveted	The Babcock & Wilcox Co.
Outlet Works			
Canyon wall valve houses	2	Reinforced concrete approx. 45x195 ft. in section 70 ft. high	Six Companies Inc.
Emergency gates	12	96-in. paradox gates and equipment	Hardie-Tynes Mfg. Co.
Needle valves	12	84-in. needle valves and equipment	Hardie-Tynes Mfg. Co.
Discharge guides	12	84-in. orifice and discharge liners	The Babcock & Wilcox Co.
Sole pieces and studs	24	42,172 lb. for 84-in. needle valves	Provo Foundry & Machinery Co.
Crane	2	30-ton traveling crane	Shaw-Box Crane & Hoist Co.
Hoist	2	3-ton mono-rail hoist for installing elevators	Shaw-Box Crane & Hoist Co.
Automatic elevators	2	162 ft. lift from P.H. floor elevation to valve house floor	Haughton Elev. & Mach. Co.
Plug outlet works and adits	2	Plugs 138 ft. in length, filling the two inner diversion tunnels	Six Companies Inc.
Emergency gates	12	86-in. paradox gates and equipment	Joshua-Hendy Iron Works
Sump and Drainage Pumps	2	Direct connected deep well type	Bingham Pump Co.
Crane	2	20-ton jib crane	Shaw-Box Crane & Hoist Co.
Hydraulic*			
Butterfly valves	4	168 in. for 115,000-hp. turbines	Hardie-Tynes Mfg. Co.
Butterfly valves	1	120 in. for 55,000-hp. turbine	Hardie-Tynes Mfg. Co.
Sphere valves	5	30 in. for 3,500-hp. turbines	Joshua-Hendy Iron Works
Turbines, draft tube lines, and relief valves	4	115,000 hp. 180-r.p.m. vertical reaction	Allis-Chalmers Mfg. Co.
Turbines, draft tube lines, and relief valves	1	55,000 hp. 257½-r.p.m. vertical reaction	Newport News Shipb'g & Dry Dock Co.
Turbines, draft tube lines, and shut-off valves	2	3,500 hp. 300 r.p.m. horizontal impulse	Pelton Water Wheel Co.
Relief valve draft tube liners	..	For four 115,000-hp. and one 55,000-hp. turbines	Consolidated Steel Corp.
Bulkhead gates for turbine draft tubes	14	To permit unwatering, inspection and repair	Miss. Valley Str. Steel Co.
Governors	4	For 115,000-hp. units—oil pressure, relay valve, actuator type	Woodward Governor Co.
Governors	1	For 55,000-hp. units—oil pressure, relay valve, actuator type	Woodward Governor Co.
Governors	2	For 3,500-hp. units—oil pressure, relay valve, Servo-motor	Pelton Water wheel Co.
Hydraulic control board	1	Operation of all gates and valves; water gages	Square D Company
Flow meter	6	U-shaped manometers for 115,000 hp. units	Bailey Meter Co.
Flow meter	1	U-shaped manometer for 55,000-hp. unit	Simplex Valve & Meter Co
Pumps	6	Deepwell type 1,500 to 6,000 g.p.m.	Victor Equip. Co.
Pumps	1	Portable high pressure	Northern Pump Co.
Water jet eductors	15	Plant drainage and cooling water for machinery	Schutte & Koerting Co.
Electric*			
Generators	2	82,500 kva., 16,500 volt, 60 cycle, 1 phase	General Electric Co.
Generators	2	82,500 kva., 16,500 volt, 60 cylce, 1 phase	Westinghouse Elec. & Mfg. Co.
Generators	1	49,000 kva., 13,800 volt, 60 cycle, 1 phase	Allis-Chalmers Mfg. Co.
Generators	2	3,000 kva., 2,400 volt, 60 cycle, 3 phase	Electric Mach. & Mfg. Co.
Transformers	7	55,000 kva., 60 cyle, 16,320-287,500 volt, 1 phase	General Electric Co.
Transformers	4	13,333 kva., 60 cycle, 13,600-138,000 volt, 1 phase	General Electric Co.
Transformers	3	1,000 kva., 60 cycle, 16,500-1,385/2,400 volt, 1 phase	Westinghouse Elec. & Mfg. Co.
Transformers	56	5 to 200 kva., 60 cycles, 2,400 volt	Moloney Electric Co.
Transformer track	1	Portable str. steel track support	Kansas City Str. Steel Co.
Oil Circuit breakers	4	287,500 volt, 1,200 amp., 3 pole, 60 cycle, single-throw outdoor type	Westinghouse Electric & Mfg. Co.
Oil circuit breakers	10	23,000 volt, 4,000 amp., 3 pole, 60 cycle, vertical lift type	Allis-Chalmers Mfg. Co.
Oil circuit breakers	2	15,000 volt, 2,000 amp., 3 pole, 60 cycle, vertical lift type	Allis-Chalmers Mfg. Co.
Oil circuit breakers	4	15,000 volt, 600 amp., 1 pole, for neutral grounding	
Reactors	3	16,500 volt, 0.68 ohms impedance, limit current to 10,000 amp.	
Bus structure	1	23,000 volt, 4,000 amp. bus with current transformers	I.T.E. Circuit Breaker Co.
Bus structure	1	23,000 volt, 2,000 amp. bus with current transformers	I.T.E. Circuit Breaker Co.
Disconnecting switches	12	287,500 volt, 1,200 amp., 3 pole, motor operated	Bowie Switch Co.

tabulation of the completed layout is as follows:

Utility	No. of Units, Kva.	Frequency	Transmission Voltage, Kv.
L.A. Bureau of P. & L....	5-82,500	60	287
Metropolitan Water Dist.	4-82,500	60	220
So. Calif. Ed. Co., Ltd....	4-82,500	50	220
Southern Sierras Pwr. Co.	2-40,000	60	138
Arizona.....	1-82,500	60	...
Nevada.....	1-82,500	60	...

Naturally, this arrangement complicates the operating problem in the power house. This, together with the control over the entire river flow, which will be retained by the U. S. Bureau of Reclamation, makes a definite operating procedure difficult to establish. In so far as possible centralized control of the main power units will be maintained, although operators on the generating floor will be furnished by companies to which machines have been allocated. As previously described, the control of each generating unit is possible from the central control benchboard or from the generator room floor. A definite operating procedure is yet to be established when more than one utility is operating in conjunction with the initial installation of the Los Angeles Bureau of Power and Light. Inasmuch as each company will furnish its own transmission circuits for the machines under its control no unusual problems should be encountered.

Equipment or Feature	Number	Rating or Description	Manufacturer or Contractor
Lightning arresters.....	4	287,500 volts, outdoor type	General Electric Co.
Control board.....	11	Miniature, Auxiliary and Terminal	Westinghouse Elec. & Mfg. Co.
Control cubicles.....	7	Complete with instruments	Westinghouse & Elec. Mfg. Co.
Excitation cubicles.....	4	Complete with instruments for 82,500 kva. units	Westinghouse Elec. & Mfg. Co.
Excitation cubicles.....	1	Complete with instruments for 40,000 kva. units	Westinghouse Elec. & Mfg. Co.
Interrupter cubicles.....	2	Lighting feeder, 115/200 volt, 3 phase	Westinghouse Elec. & Mfg. Co.
Switchgear.....	1	Station service—2,300 volt, 30 to 120 amp. with 15-kv. oil circuit breakers	Delta-Star Elec. Co.
Thermal panels.....	5	Complete with thermometers, bell alarms, etc.	Westinghouse Elec. & Mfg. Co.
Misc. switching equipment.....	..	Miscellaneous switching equipment for 2,300 volt and 16,500 volt	Wolfe & Mann Mfg. Co.
Testing set.....	1	High potential-portable, 450-kva.,0 to 36/70-kv. gen. windings and bus structure	Westinghouse Elec. & Mfg. Co.
Testing set.....	1	Dielectric—portable, ½ kva. mm., 0 to 3,000 volt, test transformer oil	Westinghouse Elec. & Mfg. Co.
Storage batteries (control bus).....	2	120 cell for 250-volt station power (640 and 160 ampere hours)	Electric Storage Battery Co.
Storage batteries (control bus).....	1	60 cell for 125-volt station power	Electric Storage Battery Co.
Storage battery charging sets.....	5	Compl. with 250-volt control and distribution switchboards	Graybar Electric Co.
Automatic telephones.....	1	200 lines maximum	Automatic Elec. Co.
Annunciator system.....	3	1 sys. for four 82,500-kva., 1 for two 40,000 and 1 for station service	Westinghouse Elec. & Mfg. Co.
Clock supply power equipment.....	1	275 meters, 115-volt, 60-cycle and equip. for operating clocks and charts	The Wolfe & Mann. Mfg. Co.
Oil purification outfit.....	3	1,200 gal. per hour capacity each	The DeLaval Separator Co.
Oil pumps.....	12	100 gal per minute capacity each	Waddin & Little Inc.
Structural Equipment			
Power house building.....	1	U-shaped, one wing at each canyon wall, central portion on dam	Six Companies Inc.
Structural steel.....	1,498,000 lb.	U-shaped, for roofs, columns, etc.	American Bridge Company
Miscellaneous steel.....	96,000 lb.	U-shaped, for roofs, generator room, crane, runway, catwalk	Miss. Valley Str. Steel Co.
Cranes.....	4	300-ton generator room—traveling	Harnischfeger Sales Corp.
Cranes.....	1	50-ton machine shop—traveling	Harnischfeger Sales Corp.
Cranes.....	1	Turbine gallery—60 and 150-ton hydraulic—traveling	Alliance Mach. Co.
Cranes.....	9	4 to 15-ton—traveling	Shaw-Box Crane & Hoist Co.
Cranes.....	375	Collector brackets for 300-ton cranes	Worden-Allen Co.
Transfer car.....	1	180-ton capacity, for moving transformers and circuit breakers	Atlas Car & Mfg. Co.
Ventilating equipment.....	9	Centrifugal fans, 7,000 to 20,000 cf./min. 11 wall type coolers	American Blower Corp.
Ventilating equipment.....	5	Propeller type, exhaust fan units	Buffalo Forge Co.
Ventilating equipment.....	7	Cabinet type surface coolers and heaters	Clarage Fan Co.
Ventilating equipment.....	11	Surface coolers and coils	Trane Co.
Ventilating equipment.....	..	Air-flow control equipment	English & Lauer Co.
Water coolers.....	11	3 to 10 gals. per hour	Day & Night Heater Co.
Water and air heaters.....	4	One for air, three for water	Grinnell Co. of the Pacific
Control circuit tunnerl.....	1	3-ton stationary hoist	Shaw-Box Crane & Hoist Co.
Control circuit tunnel.....	1	Control tunnel car, operated by hoist	Bethlehem Steel Co.
Control circuit tunnel.....	510,000 lb.	Cable supports	Midwest Steel & Iron Co.
Cableway.....	1	Permanent government cableway 200-ton cap.	Lidgerwood Mfg Co.
Lifting beam.....	1	Lifting beam and machinery-handling equipment	Consolidated Steel Corp.
Transmission Line and Switching Stations			
Towers.....	2,422	Single-circuit steel	Tower Builders, Inc.
Towers.....	272	Double-circuit, steel	McClintic Marshall
Conductor.....	1,667 miles	Segmental hollow copper, grooved interlock, 500,000 circuit, cross-section, 1.4 in. diam.	General Cable Corp.
Clamps, grading devices.....	..	.....	Locke Insulator Co.
Arcing shields.....	..	.....	Ohio Brass Co.
Insulators.....	..	10 and 10½ in. standard suspension type, 22-24 per string	Ohio Brass Co.
Overhead ground wire.....	..	.....	Copperweld Steel Co.
Counterpoise wire.....	..	.....	General Cable Corp.
Circuit breakers.....	10	3 pole impulse type, 287.5 kv., 1,200 amp., 2,500,000 kva. interrupting capacity	General Electric Co.
Disconnecting switches.....	26	3-pole motor operated 287.5 kv.	Delta Star Electric Co.
Auto-transformers.....	6	275 kv. Y/132 kv. forced air cooled, single phase, maximum rating 80,000 kw.-hr.	Westinghouse Elec. Mfg. Co.
Synchronous condensers.....	..	.....	General Electric Co.
Lightning arresters.....	..	2,875 kv.	General Electric Co.

*All installation of hydraulic and electric power plant machinery by forces of the Bureau of Reclamation.

Transmission

Unparalleled Problems of Research and Development Solved Co-operatively to Make Project Technically Feasible and Reliable

By H. C. GARDETT

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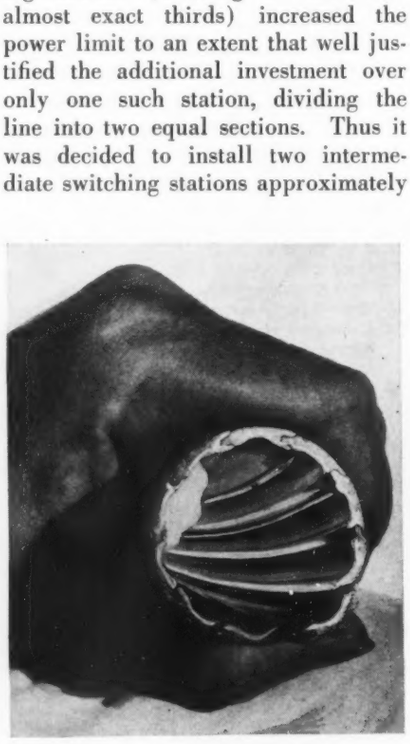
THE territory through which the route for the line had to be selected is a dry, rough semi-desert, for approximately 225 miles. In this area three mountain passes (the highest over 4,800 ft.), seasonal rainfall which at times assumes the proportions of a cloudburst, fairly frequent light storms and an almost complete absence of roads, complicated the selection of the route. At the western end a rich farming area and a densely populated metropolitan section added the consideration of the cost of the right-of-way. As selected, the route is practically air line from Boulder Dam to Los Angeles, the two three-phase, 60-cycle transmission circuits being carried on single-circuit steel towers for approximately 226 miles and on double-circuit steel towers for 40 miles, the extreme western end.

Dynamic stability of the transmission system led to early studies of the proper voltage for the line voltage being the most important factor in determining its power limit. Calculations with voltages ranging from 220 kv. to 330 kv. on the basis of delivering the first blocks of power amounting to 240,000 kw. to the Los Angeles system led to the adoption of 275 kv. as the most economical. As reported in a recent A.I.E.E. paper by E. F. Scattergood, two 220-kv. circuits with 300,000 kw. of low-reactance generators gave a theoretical power limit of 150,000 kw., three 220-kv. circuits a power limit of 280,000 kw., two 287-kv. circuits a power limit of 265,000 kw., this latter being 17 per cent more economical than the three 220-kv. circuits. While the theoretical power limit would have been increased by going to 330 kv., the large conductor diameter necessary to reduce corona losses to reasonable value and the materially increased costs of 330-kv. apparatus proved prohibitive.

High-speed switching demands met

Low-reactance generators with high inertia effects and low-reactance transformers increased the power limit some 40,000 kw., a figure which justified a liberal design of the city's machines at Boulder power plant. System power limit also is materially affected by the rapidity of switching in case of faults. The rating of this transmission system is calculated for its ability to interrupt a two-conductor-to-ground fault without losing synchronism. On the basis of transmitting 240,000 kw., interruptions of fault currents must be made in 0.11 second to maintain stability, this being much faster than the time possible with commercial equipment available at the time this line was designed. However, the high-speed switching requirements have been complied with successfully by the manufacturers with a new design.

Removal of a faulty section of any one circuit increases the system reactance, thereby adversely affecting the power limit of the whole, and calculations were made to determine the method of sectionalizing the line for maximum power limits. These revealed that two intermediate switching stations (dividing the line into almost exact thirds) increased the power limit to an extent that well justified the additional investment over only one such station, dividing the line into two equal sections. Thus it was decided to install two intermediate switching stations approximately 89 miles apart along the route of the line.



Hollow cable composed of ten interlocking segments

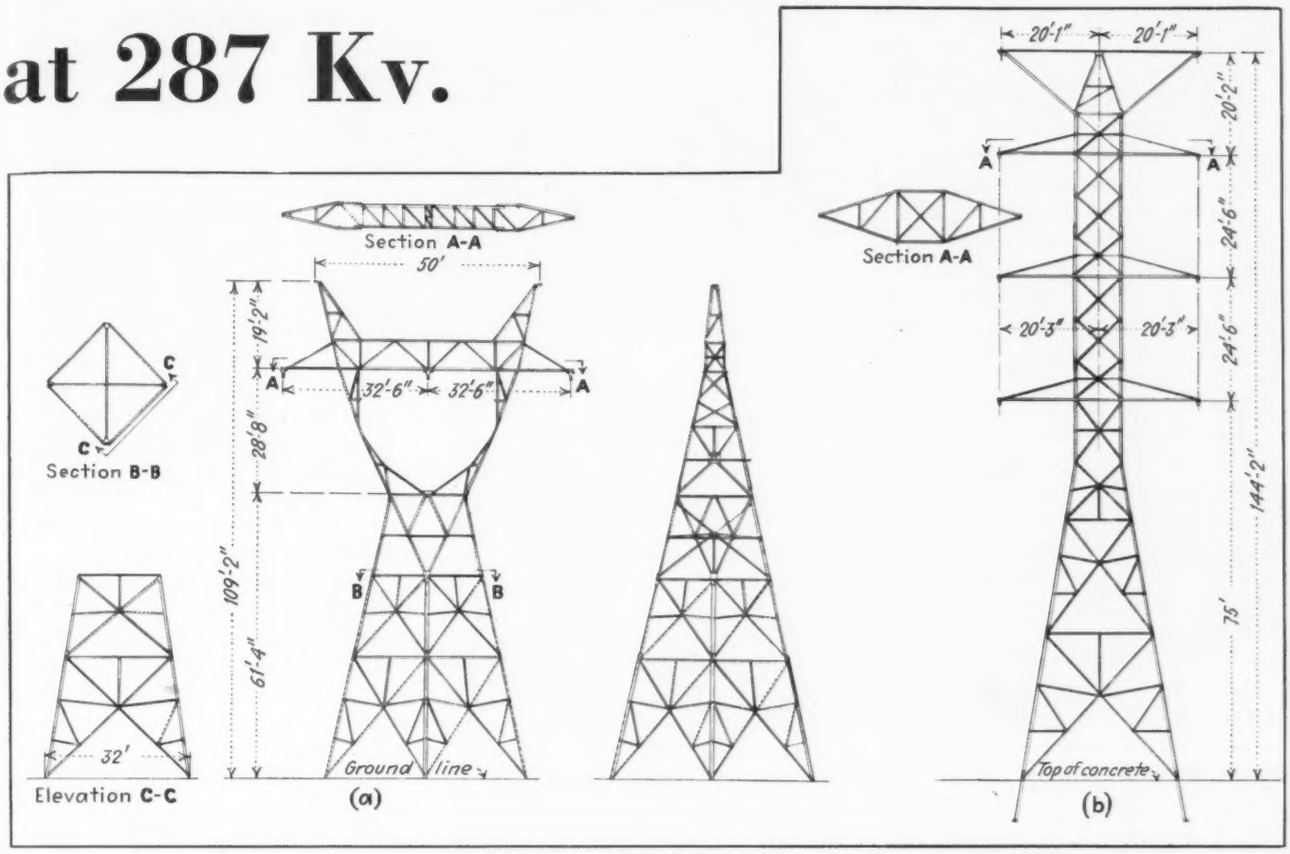
Having determined the transmission voltage and the general arrangement of the circuits, the design of the physical characteristics of the line became the next important consideration. The diameter, spacing and resistance of the conductor have little effect on the power limit of the system within operating limits, therefore the determination of these factors was evaluated in terms of reliability, economy and cost.

Towers have skewed base

The single-circuit towers are of the narrow-waisted type with the base rotated 45 deg. with respect to the direction of the line. This design gave the required strength with less weight and smaller footings, consequently less cost. Single-circuit towers are classified into three types, "suspension," "angle suspension" and "strain," and are of the same general appearance, having the same system of lower leg extensions. Variations are in the size of the members to meet the angle, span and loading conditions encountered along the route. The design permits for easy modification of the height by 10-ft. leg extensions up to 40 ft. Towers are designed for an average spacing of 1,000 ft. and a minimum conductor clearance of 27 ft. above ground at 150 deg. F., no wind. At 60 deg. F. the normal tension on the conductor is 4,370 lb. and on the ground wire 1,800 lb.

Under the maximum estimated loading of $\frac{1}{2}$ in. of ice on the conductor and a wind pressure of 8 lb. per square foot at 10 deg. F. the conductor stress is 8,700 lb., 40 per cent of its ultimate strength. Suspension towers are designed to withstand one broken conductor and ground wire

at 287 Kv.



(a) Single- and (b) double-circuit towers of two 287-kv. circuits from Boulder Dam to Los Angeles
Crossarm height 90 ft.; ground wires 19 ft. higher; flat configuration affords 32.5-ft. spacing.

simultaneously under maximum tension in the same span and on the same side of the tower.

Double-circuit towers 144 ft. high

Double-circuit suspension towers provide for vertical configuration of the conductors of each circuit, the vertical spacing being 24.5 ft. and the horizontal spacing between conductors 40.5 ft. Including a 20-ft. extension on either side of the top of the tower for ground wire supports, the total height of the double-circuit towers is 144 ft. Double-circuit towers are divided into the same general classification as the single-circuit towers and are designed for the same safety factors and conditions of loading.

All footings are of the pad and pedestal type, constructed of reinforced concrete. For single-circuit towers the average footing is 7 ft. deep with a base diameter of 4 ft. This construction developed a reaction equivalent to the weight of a 30-deg. cone of earth and proved to give greatest retaining strength in the average soil conditions encountered along the route. The reinforcing iron was placed around the stub of the footing and held together by tack welding, this being done in the camp shop. The assembled stub was transported to the site, lowered in the hole, a form placed around it and the concrete poured. All four footings for each tower were held in place during this process by a metal template to insure proper alignment for the erection of the upper members.

Location of the towers was determined from studies of the conductor sag with respect to the profile and checked by field inspection, the spans being held to as near 1,000 ft. as possible. While the details of determining tower locations and conductor-sag calculations are of great interest, due to the new methods used, space limitations prevent greater elaboration.

One of the most important single

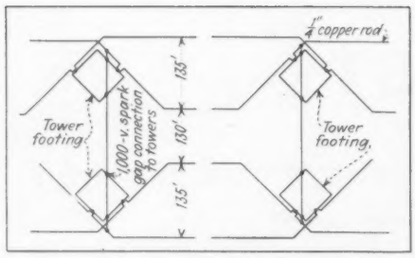
From the initial installation at Boulder power house a normal output of 240,000 kw. will be available for use of the Los Angeles Bureau of Power and Light and the municipalities of Burbank, Glendale and Pasadena. Transmitting this huge block of power 266 miles to the Los Angeles metropolitan area presented a problem which far exceeded previous practice and experience and which necessitated pioneering and research in transmission line design on a large scale. Inasmuch as Boulder Canyon power will be the main source of power for the 234,000 customers served by the bureau, reliability was a paramount consideration in the design of the transmission circuits, reliability involving not only protection from external and internal troubles inherent to transmission circuits but also new conceptions of system stability, power limits, relaying times and regulation. Efficiency of transmission, public safety, control and effective patrolling and maintenance also had to be considered.

contributions that the Los Angeles Bureau of Power and Light has made to transmission practice is the adoption of a type of conductor new to this country (introduced by the General Cable Corporation), together with exhaustive tests on the properties and operating characteristics of this new design. Up to the time that the bureau began its final studies no corona loss data were available for cables larger than 1.1 in. in diameter. Theoretically, the best cable would have the required cross-section to carry the load current with a diameter large enough to limit corona formation to a reasonable value. However, the large diameter necessary to limit corona formation at 275 kv. immediately requires a special design or else the copper area would be too large, which condition is uneconomical in the investment of both line copper and extra strength towers necessary to support the added weight.

Accordingly, the co-operation of the electrical engineering department of Stanford University was secured to permit joint investigation of the problem by the staff of the university and bureau engineers. Tests were made upon cables from 1.125 to 2.000 in. in diameter to study the effects of diameter, surface conditons, spacings, atmospheric conditions and other factors, correcting as nearly as possible for probable elevations and temperatures of the line. A conservative safety factor was deemed advisable in selecting the diameter to be used. Preliminary tests revealed that theoretically a diameter of 1.3 in. would prove the most economical from the corona loss standpoint at 287 kv. for a line of this length. However, good judgment dictated that a 1.4 in. diameter with a copper cross-section of approximately 500,000 circ.mil would be the best combination.

Various manufacturers submitted designs on this specification for additional testing. These sample cables included a variety of designs—a double layer of round wires surrounding and supported by a twisted I-beam center; a central tube surrounded by three layers of small tubular conductors, in turn surrounded by a layer of solid wires; an aluminum stranded, steel-reinforced cable; a hollow copper conductor constructed from twelve grooved segments locked together by oval wires, and a circular copper conductor made up of ten spiraled interlocking tongued-and-grooved segments.

In making a final selection of the conductor, corona tests were made on each sample. Complete annual cost estimates were prepared on the basis of tower height and span lengths made possible by the ultimate strength of the various cables. The hollow cable composed of the ten interlocking copper segments, which formed a self-supporting tubular conductor 1.4 in. in diameter with a 512,000-circ.mil copper area, proved to be the most economical from the standpoint of efficiency and other desirable characteristics. Its weight of 1.57 lb. per foot made a possible saving of 12½ per cent in the cost of towers and supports over the heavier types.



Counterpoise obtains joint effect of a radial counterpoise with a continuous installation

Conductors of low weight with respect to diameter, as this cable necessarily is, generally are considered prone to vibration. Before this cable was finally adopted exhaustive vibration studies were made in a laboratory wind tunnel and on test spans built along the route of the line. These studies revealed that the cable vibrated with amplitudes no larger than those of the heaviest cables submitted, indicative of the fact that the interlocking spiral construction is largely self-damping. The studies also were valuable in determining the design of the clamps to be used with the cable so that the little vibration that might occur would not fatigue the material and eventually cause a failure.

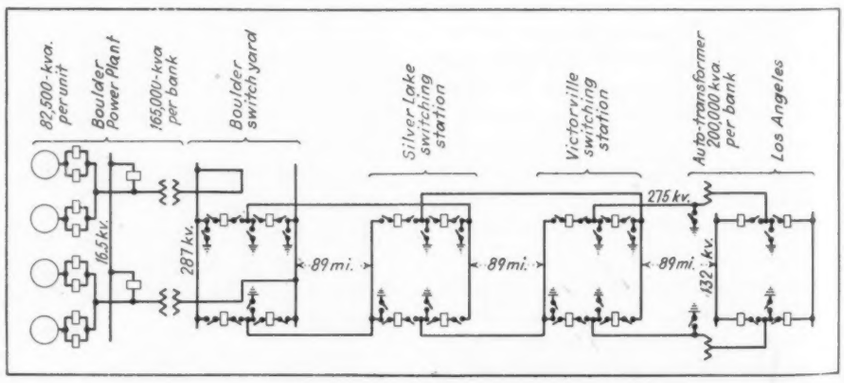
A special type of connector was developed by the manufacturer for splicing this new cable. The device consists of a supporting tubular plug which fits inside the end of the conductor. A split cone goes over the surface of the conductor. On this cone rests a second fitting of cylindrical exterior and conical interior, the interior fitting on the first-mentioned cone. Two cable ends thus equipped are placed in a bronze tube which is threaded at both ends. Cylindrical nuts are turned in these threads and force the two cones together, thus locking the cables to the outer sleeve. After this, the harder the cables are pulled, the tighter does the connector grip and it is strong enough to develop the ultimate strength of the cable.

Dead-end clamps are similar in construction except that instead of the outer sleeve being duplicated at both ends, one end is cut and the sleeve inserted into a suitable dead-end connector.

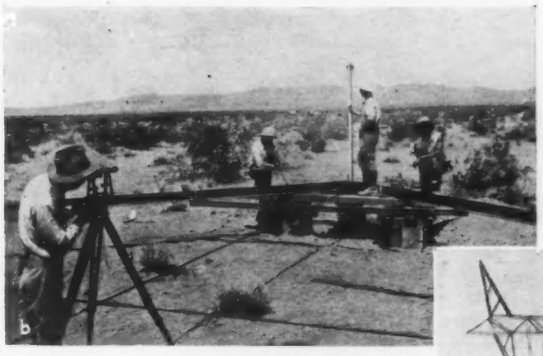
Tower insulators and hardware

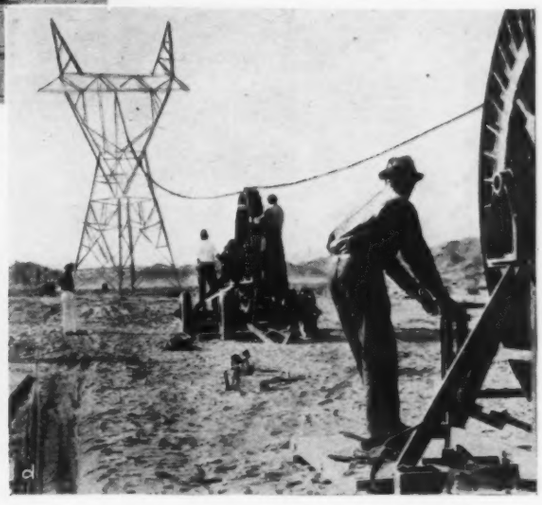
Conductors for this line are supported by means of 120-in. strings of standard suspension insulators. The length of the insulator string was determined largely by the effect of lightning striking either the tower or the overhead ground wires, the insulator flashover being more likely in the former case and the flashover between the conductor and the ground wire more probable in the latter case. It was deemed essential to co-ordinate these spacings to withstand the same lightning streamer voltage. To conform to present practice with regard to limiting the danger of a power arc following a flashover, insulator strings were increased in length by the ratio 287/220 over the existing standard for 220-kv. insulation.

Although a major portion of the



Transmission circuits trisected by intermediate switching stations





New departures in tower and conductor installation

(a) Footing reinforcement tack-welded in shop; (b) templates carefully placed to insure true alignment of footings; (c) footing bolted to template preparatory to pouring concrete; (d) conductor pulled over bull wheel which controls tension; power winch five spans distant.

line traverses a territory subject to fairly frequent lightning storms, the extreme western end is subject not so much to lightning as it is to the dust and fog conditions that promote impulse flashovers. Investigation confirmed the 120-in. string length as satisfactory for this condition also. Hence the most economical combination was found to be standard suspension insulator units, 10 in. in diameter, 5 in. spacing, and a string constituting 24 such units. Where angles in the line occurred, larger units having greater mechanical strength are used, 22 such units constituting a string. For dead-end and severe strain positions double strings of the larger units are used.

To eliminate the possibility of conductor breakage at the clamp due to vibration an entirely new clamp design was evolved. Identified as the "free-center type," this clamp consists of an outer shell suspended by strap-hangers on knife-edge trunnions. At each end of the shell and supported by it on knife edges is a metal saddle on which the cable rests, the supporting knife edges being exactly one-half a cable spiral pitch apart.

At the center of the clamp and normally free from it is a clamping piece consisting of a double conical wedge adjacent to the cable which fits into the two halves of the clamping piece itself. Ordinarily the cable merely rests upon the two saddles at either end of the clamp. Should the cable break the center clamping piece moves against a stop in the outer shell, driving the conical wedge to exert clamping action on the cable. With this type of construction bending moments due to vibration around a fixed position are eliminated, being distributed almost over a full pitch length of the spiraling. As is the case with practically all equipment used in this line, the new type clamps were given exhaustive life tests before being finally approved.

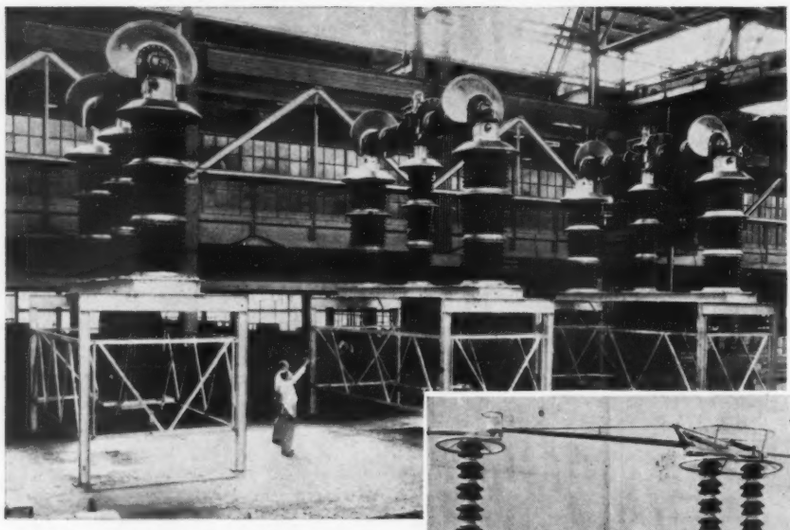
Immediately above the clamp on the suspension string is the lower arcing horn, a figure "8" formed from 1¼-in. pipe. The upper arcing horn at the grounded end of the string is a formed 1¼-in. iron strap emanating from each end of a metal bird guard.

Protective features of the line

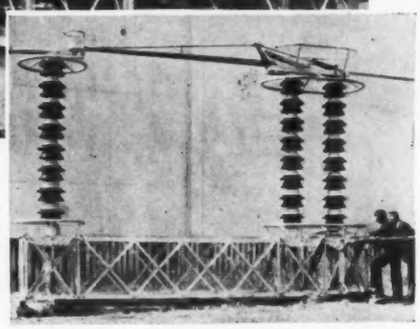
Elaborate precautions have been taken to eliminate outages from sources both external and internal to the transmission system. Protective features naturally fall into two classifications, those for lightning and those for internal troubles. In order to limit flashovers due to lightning to a minimum, past experience dictated that two ground wires per tower be installed. The efficacy of this protection would, however, be questionable with the high impedance of the tower footings which could be expected in the dry, rocky soil of the desert. Past experience with a counterpoise to reduce this impedance having proved quite successful, the results that could be expected from the use of a counterpoise with this transmission system were studied and evaluated on an economic basis. From these studies it was determined that tower footing impedances between 17 and 25 ohms would be necessary to reduce the possible flashovers from lightning to less than one per year per 100 miles of circuit. To obtain this low value of impedance it was found necessary to install two counterpoise wires per circuit, cross-bond them at each tower and connect the two circuits together. Evaluation of the relatively low cost of such an installation with the means of obtaining equal reliability with increased line insulation was preponderately in favor of the counterpoise.

The counterpoise installation is of interest not only for its layout but also for the method of installation. As best suited to withstand both the corrosion and the mechanical strain of installation, a soft black copper rod ¼ in. in diameter was selected for the counterpoise. Wires were installed in a configuration which takes advantage of the low surge impedance of the radial type counterpoise and, being continuous, eliminates the possibility of end reflections present in the conventional radial design.

On account of possible electrolytic action between the copper rod and the tower steel, the counterpoise rods are not bonded directly to the tower footings but connected through a specially



One of the 287-kv. breakers that operate in three cycles and is rated 2,500,000 kva.



One pole of 287-kv. disconnecting switch

designed spark gap constructed of two concentric brass rings having a $\frac{1}{16}$-in. air gap between—small enough to break down at 1,000 volts. A small percentage of fault potential will thus bring the counterpoise into action.

Intermediate switching stations

To appreciate the electrical protection installed on the system, a brief description of the intermediate switching stations is necessary. These stations, which divide the line into approximately three equal parts, permit isolating a section of one circuit not longer than 89 miles without materially affecting stability of the system. One line and the two circuit breakers on either side can be removed without affecting the operation of the three other lines, the capacity of the one line section left in being sufficient to absorb the load previously carried by the faulty section.

Also of interest is the fact that the counterpoise installation under the line is fanned out to form a ground mat under the intermediate switching stations. The overhead ground wires, however, are not connected to the conventional structural steelwork supporting the buses, but are bonded to steel towers 150 ft. high which are connected to the counterpoise ground mat. The location and height of these towers maintain the ground wires in such a position as to shield the station from direct lightning strokes.

The circuit breakers, of which there will be four three-pole units at each intermediate switching station and two three-pole units at the receiving end of the line, are of an entirely new design, developed by the General Electric Company for the high-speed operation and the high interrupting capacities that can be expected when operating above 220 kv.

With these breakers the speed of operation is less than three cycles from the initiation of the tripping impulse to the interruption of the circuit. Features of high-speed operation are improved stability and reduced maintenance. With one cycle less of arcing negligible burning of the contacts and slight oil deterioration can be expected. The advantages of the small oil volume are that no special handling equipment is required, the low weight simplifies foundation problems and difficulties of transportation and erection, draining and filling can be accomplished in a short time, with a large saving both in first cost and replacement of oil. Electrically, these breakers are rated at 2,500,000 kva. and will interrupt a 5,000-amp. current at 287 kv. in less than three cycles. Physically, a complete three-phase unit of this design weighs approximately 110,000 lb., as compared with 290,000 lb. for a breaker of the conventional, tank-type design. The oil content is approximately 2,600 gal., compared with 23,000 gal. for the tank-type breaker. For the receiving end of the line, after the voltage has been stepped down to 138 kv., the circuit breakers consist of one four-break impulse unit instead of two such units in series as are used at 275 kv.

Carrier and conventional relaying

Two systems of relay protection are installed on the line. The first is the conventional balanced relay scheme in each section of the line. The second system is the carrier-current relay system of the lock-out type. The balanced relay protection operates in 0.03402 second and the carrier-current relay system in 0.05 second, so that normally the former will operate first, the carrier relay system acting as "back-up" protection and as protection when one circuit of a section has been relayed out.

The carrier-current relay system is of interest because of its directional characteristics. With it there are two

A portable cement plant mounted on a truck with trailer water tank was necessary to pour tower footings in the desert

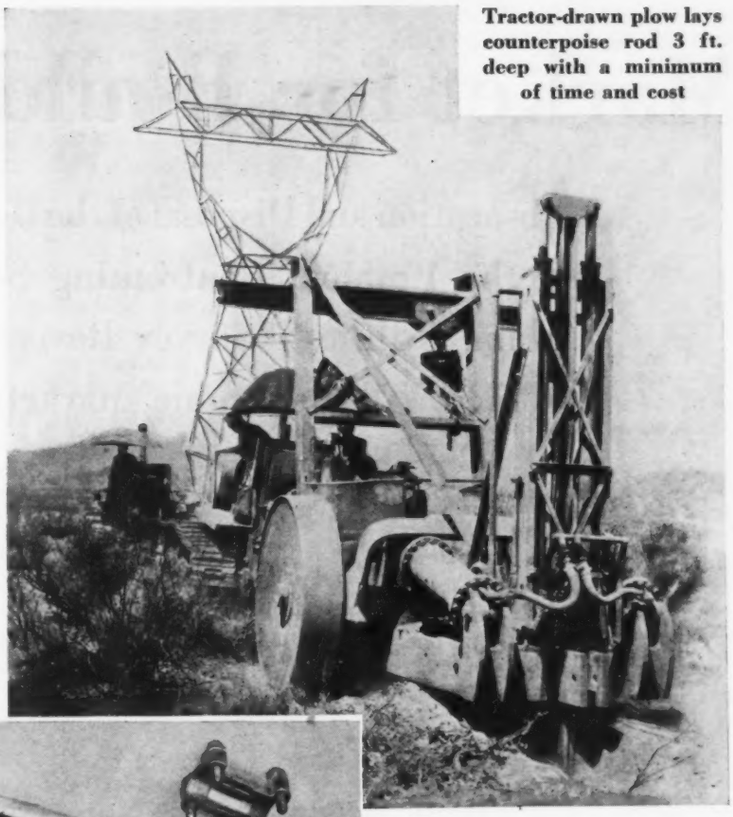
sets of relays per conductor at each end of each section of the circuit. One set is the fault relays which will move toward the trip position in case of a fault anywhere on the system. The second set is the directional relays which check the direction of power flow in each section. If the direction is normal at the two ends of any conductor in a circuit, a carrier signal is initiated which prevents the circuit breakers on that particular section from tripping. Should the fault be in a particular section the power flow would be reversed at one end of the conductor and no lock-out action would take place, allowing a completion of the trip circuit of the circuit breakers at each end of that particular section.

Control of the connected apparatus in this transmission system can be accomplished in three different ways by a carrier-current supervisory control system operated from the Boulder power house, by electrical control from the switchboards at each switching station, and by manual operation.

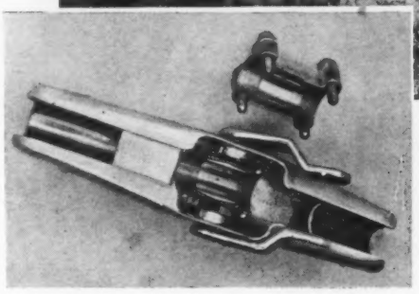
Normally, the control will be in the hands of the Boulder power house operator, who, by means of standard supervisory keys, can open or close any circuit breaker or ground switch in any of the stations. A record of the switch operations is returned through colored indicating lights on his switchboard. In case of an automatic operation the operator also gets a signal light indication, as does the dispatcher at Los Angeles, who also has an indicating board which shows the position of switching equipment at all 287-kv. stations, although he has no control over any of the switches except those at the receiving station.

Patrol cars can be called

Communication also will be provided by a separate carrier-current installation, although wire circuits will be available as well. Of particular interest in connection with the communication system is the car-calling provision by which all patrol cars along the line will be under instant supervision of the dispatcher. Patrol cars are equipped with radio telephone receivers tuned to a carrier-current frequency superimposed upon the line over which the dispatcher will issue orders by a telephone from his office. His conversation is transmitted over the line and picked up by the various patrol car receivers. This innovation is expected to increase the efficiency of patrol crews many times.



Tractor-drawn plow lays counterpoise rod 3 ft. deep with a minimum of time and cost



"Free-center" clamp developed to minimize cable vibration fatigue

It is interesting to note that there are four separate carrier-current applications on this transmission system. These are (1) carrier-current relaying; (2) supervisory control; (3) telephone communication; (4) patrol car broadcast communication. The "A" phase of both circuits is reserved for the relay carrier current, each line section having a different carrier frequency for operating the relays of that particular section. The "B" phase of the north circuit and the "C" phase of the south circuit will be used for supervisory control and the "C" phase of the north circuit and "B" phase of the south circuit for communication.

Each of the two 275-kv. circuits terminates in a bank of three single-phase auto-transformers, each rated for 275,000 Y/132,000 with a 13,200-kv. tertiary delta winding, single-phase, 60-cycle 48,750 kva. without blowers, 65,000 kva. with blowers, 80,000 kva. for two hours with blowers. They are the largest auto-transformers built to date and each weighs 332,000 lb.

These auto-transformers are located at and are connected to the 132-kv. bus of receiving station B of the Los Angeles Bureau of Power and Light through four 1,200-amp. oil circuit breakers of the impulse type, having the same speed and interrupting capacity as the circuit breakers in the intermediate switching station except for their 138-kv. voltage rating.

The conventional method of controlling the transmission line voltage by using synchronous condensers is used on this line. From the constants of the system it was found that a voltage ratio of 1.05 to 1 between the sending and receiving end voltages provided maximum economy on condenser capacity.

For a receiving voltage of 275 kv., it is therefore necessary to provide 287 kv. at the bus in the Boulder Canyon switchboard. Synchronous condensers will be connected to the 60,000-kva. tertiary winding of three winding transformers supplying the 33-kva. bus sections from the 132-kv. bus. The synchronous condensers, of which there will be two in the original installation, are rated 60,000 kva. leading, 26,000 kva. lagging, 600 r.p.m., 13.2 kv. hydrogen-cooled arranged for outdoor installation.

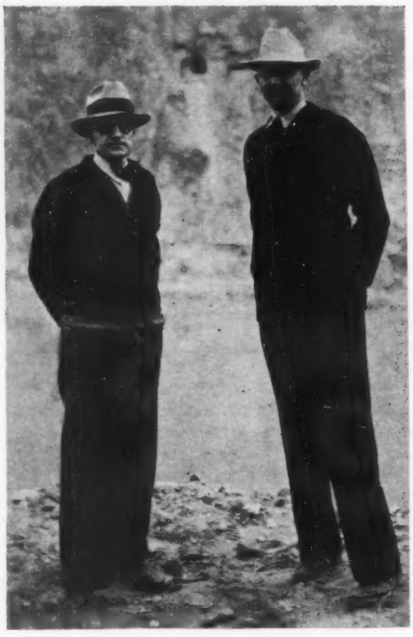
Market for Boulder Power

Absorption and Disposal of the Boulder Output Is the Problem Confronting Southern California Utilities—Survey Reveals the Factors Which Will Determine Marketing Prospects

WHILE no one can deny the beneficial aspects of Boulder Dam from the irrigation, flood control and water supply standpoints, the problem of disposing of its energy output is a perplexing one. At the inception of the project (1928) there was no indication that the depression years of 1930-34 would adversely affect the normal load growth in that area to the extent that has been experienced. Had normal growth of 1920-1930 continued, Boulder Canyon energy would have been easily absorbed and contractual agreements entered into with the Bureau of Reclamation by the various municipal and private utilities operating in Southern California would not have involved any particular operating problems.

Briefly, the situation with regard to the disposal of Boulder Canyon energy dates back to May, 1930, when power contracts with the Bureau of Power and Light, the Southern California Edison Co., Ltd., and other utilities in Southern California were signed. This assurance of a fixed revenue upon its completion provided that the Boulder Canyon project would be self-liquidating and eventually provide a fixed return to the government and the states of Arizona and Nevada. The 4,330,000,000 kw.-hr. of firm power from the project was contracted for as follows:

Company	Firm Power Contracts (Kw.-Hr.)	Approximate Annual Payment at 1.63 Mills
Southern California Edison	917,000,000	$1,495,000
City of Los Angeles	1,485,000,000	2,420,000
Los Angeles Gas & Electric	114,000,000	185,000
Southern Sierras Power	114,000,000	185,000
Pasadena, Glendale, Burbank	174,000,000	284,000
Metropolitan Water District	1,526,000,000	2,481,000
Total	4,330,000,000	$7,050,000



Walker Young (left), resident engineer for the U. S. Bureau of Reclamation, and F. T. Crowe, general superintendent of the Six Companies, Inc., are responsible for the rapid progress that has characterized the completion of the Boulder Dam project

In addition to the $7,050,000 realized from the sale of firm power, approximately $775,000 is expected from the sale of secondary or dump power. This income, plus that from water sales, is to repay the government for the costs of the project with interest at 4 per cent. The remainder over and above the costs of operation and maintenance is to be divided between the states of Arizona and Nevada and the U. S. government, the states getting 18¾ per cent each and the government 62½ per cent, which will be used for further development of the Colorado Basin. If this return is realized the $165,000,000 total cost of the project and a return of $104,000,000 to the government and $31,200,000 to each of the two states will be realized in the 50-year period that follows the completion of the project.

Under the terms of the power contracts users agree to pay the United States a charge of 1.63 mills per kilowatt-hour delivered at Boulder Dam at transmission voltage for the use of falling water used to generate power. In addition to this charge for the use of falling water the lessees of the power plant are required to operate and maintain the power plant and repay the cost of the generating equipment installed therein for their use in the first ten years of operation. The total cost of electrical energy at Boulder Dam comprises the 1.63 mills per kilowatt-hour charge for the use of falling water, operation and maintenance of the power plant, and interest, depreciation and amortization of the cost of the generating equipment.

The cost of electrical energy delivered at transmission-line voltage at Boulder Dam for load factors of 50, 75 and 100 per cent is shown in Table I.

Excess capacity not absorbed until 1950

Conditions relative to the quick utilization of Boulder Canyon energy have changed materially since 1930, as an inspection of Table II and the accompanying illustration will show. This tabulation of present capacity load and surplus indicates the extent to which the power market is suffering from overproduction at present.

Of course, it is apparent that the ultimate capabilities of Boulder Dam probably will not be made immediately available even though the water

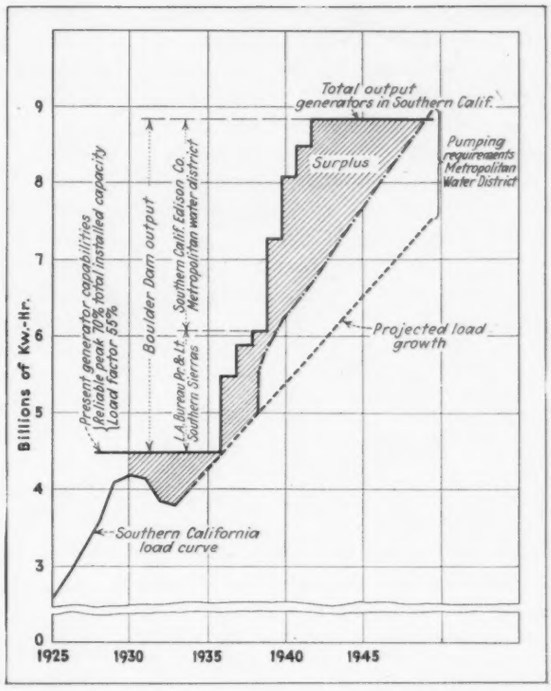
will be available as soon as the 30,500,000-acre-ft. reservoir behind the dam is filled. In the illustration various relationships between load and generating facilities in normal years are depicted graphically. On the basis that the requirements for normal growth will increase in yearly increments of approximately 200,000,000 kw.-hr. to approximately 7,500,000,000 kw.-hr. in 1950, plus the pumping energy required along the Metropolitan Water District aqueduct, it can be seen that the surplus in average years, beginning with about 1,000,000,000 kw.-hr. in 1936, reaches a maximum in 1942 of 1,700,000,000, and thereafter tapers down until in 1950 the load requirements exceed the capabilities of the generators in the southern California area. Although these figures are conservative, this surplus will be increased proportionately if the load growth fails to increase at the rate indicated.

Most of the surplus shown would be in the hands of the L. A. Bureau of Power and Light and the Metropolitan Water District. Its disposal in the southern California area is complicated by several factors, probably one of the most important of which is the two different frequencies at which the major systems of the territory operate. The Southern California Edison Company, Ltd., which distributes approximately 60 per cent of the power in the area, operates at 50 cycles and has a total generating capacity at present of 949,940 kva., of which some 450,000 kva. is in steam turbine prime movers.

All of the other large utilities will operate at 60 cycles, the L. A. Bureau having just announced a changeover from 50 to 60 cycles to begin immediately. Hence interchange between the Edison company and other southern California utilities of power in large blocks will involve expensive frequency changer units. Inasmuch as the bureau will rely largely on Boulder Dam as a prime source of power, and in spite of the extreme precautions that have been taken to make its transmission circuits as reliable as possible, some steam reserve is desirable near its load center, and the desirability of frequency changing equipment to make some of the steam capacity of the Edison Long Beach steam plant available for emergency and peak requirements on the Los Angeles bureau's system is now being studied.

In so far as the Edison company and the Los Angeles Gas & Electric Corporation are concerned (the latter operating a large steam plant at Seal Beach, some 25 miles south of Los Angeles), energy from Boulder Dam is not particularly attractive as long as the present capabilities of their respective systems are sufficient to supply their load requirements. At the present prices of natural gas in that area a modern steam plant can generate energy for approximately 3.5 mills per kilowatt-hour.

With the total costs of Boulder Dam power at the plant switchboard of some 2 mills per kilowatt-hour plus transmission losses of 10 per cent and transmission costs over the 275 miles (estimated to be approximately 1 mill per kilowatt-hour for energy in 100,000-kw. blocks at 75 per cent load factor), it is readily apparent that steam-generated kilowatt-hours are extremely competitive with those generated by Colorado River water, as well as those generated by the present



Boulder power portends rising surplus for next decade

Table I — Cost of Electrical Energy at Boulder Dam*

Mills Per Kilowatt-Hour

	50 Per Cent Load Factor	75 Per Cent Load Factor	100 Per Cent Load Factor
Charge for use of falling water	1.630	1.630	1.630
Cost of generation:			
Operation and maintenance	0.103	0.067	0.052
Interest, 4.75 per cent	0.304	0.203	0.152
Depreciation	0.113	0.075	0.056
Amortization, 1.107 per cent	0.071	0.047	0.036
Total cost per kilowatt-hour delivered at high voltage at Boulder Dam	2.220	2.020	1.930

*U. S. Bureau of Reclamation figures.

Table II—Generating Capabilities of Southern California Systems*

	Installed Capacity	Output Capability* Peak-Kw.	Output Capability* Energy	Boulder Dam Gen. Cap.	Boulder Dam Firm Power	Capability Output*	Output (1933)
Southern Cal. Ed. Co.	949,940	665,000	3,200,000,000	330,000	916,000,000	4,117,000,000	2,772,000,000
L.A. Bureau of Pwr. and Lt.	138,257	97,000	460,000,000	577,500	1,484,900,000	1,945,000,000	312,000,000
L.A. Gas & Elec. Corp.	169,575	119,000	570,000,000	†	114,300,000	684,000,000	356,000,000
So. Sierras Pwr. Co.	80,726	57,000	270,000,000	80,000	114,000,000	384,000,000	245,000,000
Pasadena, Glendale and Burbank	35,500	25,000	120,000,000	‡	173,000,000	294,000,000	87,000,000
Metropolitan Water Dist.	.....	.....	.....	330,000	1,526,400,000	1,526,400,000	.....
Total	1,373,898		4,620,000,000	1,317,500	4,328,600,000	8,950,400,000	3,772,000,000

*Based on 70 per cent dependable peak and 55 per cent load factor. †Combined with Southern Sierras Power Company.
‡Supplied through Los Angeles Bureau of Power and Light.

hydro plants of the southern California companies. Hence as long as the load requirements of the various systems do not tax their existing facilities, utilizing Boulder Dam energy would involve direct operating losses in investments in existing generating facilities. Conversely, when the load requirements exceed present capacities, Boulder Dam power at 3 or 3.5 mills will become considerably more attractive.

Northward flow of energy

Assuming that the load growth in central California will parallel that shown in the accompanying illustration it has been estimated that some of the surplus existing in southern California from 1937-1945 could be utilized in the northern part of the state by reversing the direction of the power flow from the Big Creek plants of the Southern California Edison Company, Ltd., located some 200 miles north of Los Angeles. The output of these plants is now utilized in that city, but under certain dry year conditions some of this capacity could be transferred advantageously into northern California by means of an interconnection with the San Joaquin Light & Power Corporation. Frequency-changing equipment is not required for such a tie, as certain Big Creek units, capable of operating at either 50 or 60 cycles, could be isolated from the Southern California Edison system and generate at 60 cycles. These units could be connected directly into the Pacific Gas & Electric Company system by means of a 40-mile transmission line constructed between Big Creek No. 3 and Herndon, the southern terminus of the Pacific Gas & Electric-San Joaquin Light & Power Companies' interconnected system.

Generally speaking, the market for Boulder Dam power lies primarily in the continued growth of southern California both as an industrial and agricultural community. Such a growth presupposes increased domestic utilization plus greater electrification of home, farm and factory. In the light of the present unsettled economic conditions many will take a pessimistic attitude toward the ability of that section to utilize this tremendous block of power within the next two decades. Some are fearful that the disposal of surplus power may increase the friction between the various distributing agencies in the territory.

Due to economic conditions, the smaller municipalities have asked for and received permission to extend the time for absorbing their contracted share of the energy from the project. As originally intended, contractual parties would have had to take the stipulated amount of power at the completion of the project, subsequent modification extending this time so that Pasadena, Glendale and Burbank may take 50 per cent the first year, 70 per cent the second year and 85 per cent the third year, thereafter taking their full allotment. The Southern California Edison Company, Ltd., is obligated to take only 55 per cent of its total allocation in either 1938 or 1939, depending upon when energy was available.

Advance completion complicates

Further complicating disposal of the power is the fact that the initial installation will be completed approximately two years ahead of schedule, which raises the question of power disposal in the interval between completion of the project and the dates set forth in the contracts for the various utilities to begin taking energy. This problem is thrown back indirectly upon the Edison company because the Los Angeles Bureau of Power and Light will be in a position to take the output of the four initial units immediately (about twice its present requirements) and, undoubtedly, will cease to purchase power from the Edison company as has been done up to the present.

As a new source of energy Boulder may invoke a hardship on the utilities contracting disposal of its output because their contracts specify that after the period specified for them to take power they will be charged for the stipulated amount of power at the regular rate of 1.63 mills per kilowatt-hour for the falling water, whether it goes through the turbines, through the diversion tunnels or over the spillway. In view of the marked change in economic conditions since the contracts were signed, it does not appear equitable to force the contracting parties to write off the investment in the project in the time specified.

However, no serious consequences or alarm should result if complete utilization of Boulder Canyon power is not realized immediately, as the importance of the area insures its growth to a point where it will easily absorb the power output of the project. Should this be deferred five or ten years longer than was originally anticipated, the net loss to the government would be the interest on the investment in the unused portion of the power plant.

"Wheeler-Rayburn Bill Most Drastic Ever Approved by Either House"

THE President declared in his last fireside talk that this legislation was a positive recovery measure, and that this bill will not destroy values. I usually give the President credit for believing what he says, but to my mind this statement is nothing less than silly and is without foundation. You cannot destroy an institution that is legitimately expending three-quarters of a billion dollars a year, and then say that such act is in the interest of recovery.

I am sorry that I cannot offer any definite explanation of the President's determination to have done that which is sure to bring so much distress to so many people.

In my judgment, this much of the New Deal program will not become effective. It may pass the Congress and will, of course, be approved by the President, but we have had demonstrated within the past three weeks that one branch of our government, namely, the judiciary, remains untarnished by new theories of government and unafraid to declare them unconstitutional.

Under the present conditions, the Supreme Court is the hope for America.

SENATOR DANIEL O. HASTINGS
of Delaware in a recent broadcast address.

Man-made daylight shows artistry of cars in true colors

Advanced Lighting in Auto Showroom

By HOWARD KETCHAM
E. I. Du Pont deNemours Company, Wilmington, Del.

DICK CLOVER
General Electric Vapor Lamp Company, Hoboken, N. J.

EVERY square foot of the new Chrysler showroom in Detroit has been given an intensity of 20 foot-candles at eye level. The quality was aimed to be the best simulation of artificial daylight yet devised. Each of the 66 ceiling fixtures has a 1,000-watt "Mazda" lamp and a 450-watt circular mercury-vapor tube.

Colors appear to best advantage under good daylight conditions. Incandescent light is unbalanced and tends to impart a distorted effect to colored surfaces. In the cast of maroon, the preponderance of red and yellow rays reflected produces an orange tint. Under mercury-vapor light maroons lost identity because this light contains scarcely any red rays and a predominance of the blue. Blue light on maroon tends to lower the apparent value of the pigment. In general, wherever the light is colored its tint modifies the appearance of everything that it illuminates.

The color supplier imparts his skill to counteract undesirable off-color tendencies in his color products. His developments fall short of their fullest sales promotional possibilities if the effectiveness of these new colors when displayed at night (and a majority of all retail automobile sales are consummated at night) is depreciated.

Car sales can now be closed just as readily at night as during the day. There is no glare, nor are there any shadows, in a properly lighted showroom. All details are easily seen. The pupils of the eyes remain normal and wide open, indicating a complete absence of eyestrain. Aside from the splendid general impression conveyed by illuminating cars so that details of design, color and interiors appear at their best, there is an element of effective showmanship entailed in the use of synthetic daylight. When lights such as these are on at night cars passing the showroom are slowed down or stopped by the novel effectiveness of the natural looking light.

The new Chrysler showroom is located in front of the Jefferson Avenue plant, Detroit, Mich. This two-story terra cotta building is 50 ft. wide and 500 ft. long. The main showroom for displaying all Chrysler models to distributors, dealers and customers is 350x50 ft. The ceiling is 20 ft. high. There is a circular reception lobby at each end of the main showroom. The Chrysler retail showroom occupies the east end of the building, and the west end of the building is occupied by the De Soto retail salesroom.

The lighting units are all specially designed and built into the general construction.

The lighting installation consists of 66 ceiling fixtures with white porcelain enamel reflectors in which there are one 450-watt circular mercury-vapor tube and one 1,000-watt "Mazda" lamp above the ceiling. The fixtures below the ceiling consist of four 32-in. brushed aluminum rings with 2-in. spacers. The flashed opal glass is supported by the bottom ring, which is hinged for accessibility.

These fixtures are arranged on 16x16 ft. centers; each 1,450-watt fixture, lighting 256 sq.ft. of floor area at approximately 6 watts per square foot, gives an average intensity of 20 foot-candles on the eye level.

Window fixtures consist of fourteen 24-trough built-in lighting units, 22 in. wide, with white enamel reflectors. Each 24-ft. section contains five 50-in. straight mercury-vapor tubes and 40 100-watt "Mazda" lamps.

The current consumption of the window fixtures is approximately 300 watts per linear foot; the average intensity of the front portion of the showroom is about 50 foot-candles.

The current consumption of the ceiling and window fixtures is approximately 12 watts per square foot. The total consumption is about 200 kw. As the showroom is adjoining the factory, the current cost is

[*Continued on page 77*]

Mr. and Mrs. Smith

Share-the-Wealth in Action in Their Factory Home—Rates Go Down While Other Costs Increase—What They Pay and What They Get

By RAYMOND S. TOMPKINS

OF ALL the surprising things that went on practically unnoticed in the world around us there was probably nothing more surprising in 1934 than the operation of Mr. and Mrs. John Smith's "household factory." Mr. and Mrs. Smith are typical Americans. They might be anybody. They are deeply interested in the cost of living, and in making life as enjoyable as possible at a minimum of expense.

In 1934 they conducted an extensive manufacturing operation at home. Its by-product was the health and contentment of Mr. and Mrs. Smith and their children. Its real products were all the commodities and services that a typical American household turns out for the purpose of carrying on the fundamental processes of existence and for making life worth living.

In this household factory Mr. and Mrs. Smith used a number of complex and delicate but strongly constructed machines. They ran them by electricity. And—here was the surprise—the total cost of the power required to make these machines function for the entire year 1934 was $67.56.

For that amount of money they lighted the whole house, did all the family ironing, kept the house free from dust and lint and preserved the color and texture of the Oriental rugs and the upholstery on the furniture with a vacuum cleaner; kept all the food cool and wholesome in a refrigerator and had plenty of ice for all purposes, and did all the cooking and baking.

They took this as a matter of course until they began reading in the newspapers how the price of everything was going up. It didn't take Mrs. Smith long to discover that the papers were telling the truth. With downcast eyes the grocer was forced to tell her that practically everything she bought on her Saturday marketing was higher. With doleful voice the butcher told her the same thing. In accents low she got the same story down at the dry-goods store.

IT WAS then that Mr. and Mrs. Smith rummaged feverishly through the desk and got out their old last year's electric bills and likewise dug up their electric bills so far for 1935. They were astounded to find that in 1934 they had spent less for electricity than for virtually anything else they had used in running the house, and also that it wasn't costing them any more in 1935 than it had cost them in 1934, in spite of the fact that everything else was up.

Mr. and Mrs. Smith are therefore among the people who are not entirely clear in their minds about this "power problem," which seems to be worrying some folks in Washington. They have a general understanding of it, of course; that some people in the government think the electric power people are not to be trusted and ought to be more rigidly policed, perhaps even taken over by the government. But on the face of their electric light bills they see no reason for this; nor from the standpoint of results, either. The refrigerator functions well, the vacuum cleaner did wonderful work, the electric iron never failed once, the electric stove did a swell job on the Thanksgiving and Christmas turkeys, and the only trouble with the lights was when they had to get new bulbs for the bathroom and the living room a couple of times. And it all cost only $67.56 for the whole year.

THERE were neighbors of Mr. and Mrs. Smith's whose electricity bills were more than that, and there were other neighbors whose bills were less. There were other families in other cities, some remote from the city the Smiths lived in, some closer by, who had similar experiences, perhaps paying a little less for the same electric service, perhaps paying a little more, but all discovering, as the Smiths did, that groceries and meats and clothes might be going up in price, but electric service was coming down.

The cost of the service was diluted by the use of it. Take the Browns, for example, who lived on the other side of town from the Smiths. (Mind you, this isn't any particular town, it's an imaginary town where these electricity costs represent nation-wide residential averages.) The Browns did some housework by electricity, too, but not as much as the Smiths. The only piece of "machinery" they had was Mrs. Brown's electric iron, and they had electric lights, too, but fewer than the Smiths. Their electric bill for the whole year was $19.20.

Both the Browns and the Smiths paid for their electricity at so much per kilowatt-hour. The Browns, who paid only $19.20 for a year's supply of electric current, used only 240 kilowatt-hours during the year, while the Smiths, who paid $67.56, used 3,000 kilowatt-hours. But there, if you have noticed it, is a curious thing. The Smiths, it is true, paid three and a half times as much as the Browns, but they used twelve and a half times as much electricity. How did it happen that the Smiths got twelve and a half times as much electricity as the Browns, and only paid three and a half times as much for it? Is there favoritism here? Is this one of the "improprieties" the New Dealers are talking about in the light and power business?

The answer, of course, is that it is quite the reverse of an impropriety. This is a demonstration of the electric power law of decreasing price based on increasing consumption—a law that cannot be repealed even by repealing the Constitution. What happened was that, since the Browns used only 240 kilowatt-hours during the year, their rate was 8 cents per kilowatt-hour, and 8 cents times 240 is $19.20, while the Smiths, who used 3,000 kilowatt-hours, earned a rate of 2¼ cents per kilowatt-hour, and 2¼ cents times 3,000 is $67.56.

These figures are average figures for the Browns and Smiths all over the country, and it can be assumed

Do Some Figuring

that if Mr. and Mrs. Brown had lived in every town in the United States during 1934 their electrical service for the year would have cost $19.20, and if the Smiths had done the same their electrical housekeeping would have cost them no more than $67.56. It might have cost them a little more in one town and a little less in another town, but when the year was up the average figures would have been the ones we have given.

And by the same token, they would have discovered, wherever they had moved, that the cost of virtually everything else they used in the house was higher instead of lower. If they had kept their housekeeping bills for 1913 (which they probably had not) they would have found that today their American dollar was buying them one and one-third times more electric light, but one-fourth less milk, 30 per cent less meat and one-fourth less clothes than it bought in 1913. And for the dollar they spent for current to run the vacuum cleaner, the refrigerator, the electric range and flatiron, they would have discovered that they were getting one-third more current in 1934 than they got in 1913, but for their bread dollar they were getting 32 per cent less bread, for their potato dollar they were getting 5 per cent less potatoes, for their coal dollar they were getting one-third less coal, and for their postage dollar Mr. Farley was giving them one-third less letter postage in 1934 than Mr. Burleson gave them as Postmaster-General in 1913.

In some cities they would have found the kilowatt-hour rates for electricity very low, indeed; much lower than the national residential averages which the Browns and Smiths paid in the average town. If they could have skipped into and out of 46 particular cities, for example, they could have had a rate of only 2 cents per kilowatt-hour for using as little as 500 kilowatt-hours, and in 127 other cities they could have had a rate of only 2½ cents. And in some places if they had stayed long enough, they would have found their electric light and current rates actually getting reduced every week!

THE Browns and the Smiths might well ask, "Why these discrepancies in electric rates?" The answer is simple, but first they had to know what they were paying for. They were paying for the tall steel towers that they could see while out driving in the country; marching across the land through cleared aisles in the forests, mile after mile, bearing looped across their shoulders the transmission lines that carry the current. They were paying for the great concrete dams and gigantic man-made waterfalls operating the hydro plants, and for the big steam plants all over the country, where the current was generated. They were paying for the millions of miles of lead-covered cables full of electric wires laced beneath the surfaces of city streets like systems of veins and arteries, from Bangor, Me., to Santa Barbara, Calif., and everywhere in between; for the poles and wires that distributed current out in the country; for the equipment and men who leaped at the call of trouble like firemen leaping at the sound of a fire gong; for the cost of keeping up a central headquarters to look after all these things, and for the thousand and one details that have to be done on top of all this, such as reading the meters, making it easy to report troubles, sending the bills, even keeping track of them and collecting them.

Now, the reason that the Browns' and Smiths' bills were smaller in some localities and larger in others was that all these things cost less in some sections of the country and more in others. For example, a transmission line would cost only $7,000 a mile in the open country, but in a congested city area, where rights-of-way were expensive, the same line might cost $1,000,000 a mile. Again, a substation might cost only $12 per unit of electrical capacity, since it might represent only a few transformers on wooden poles. But if it were a beautiful little building in a city street, appropriate in architecture to its surroundings, it might cost $80 per unit of capacity. They would have been customers of companies with overhead systems having unit costs of, say, from $50 to $300 per customer, or they might have been customers of companies with underground systems, having unit costs per customer of from $150 to $1,000. Naturally, the lower the cost of producing the current the lower the bills of the Browns and the Smiths, and *vice versa.* This was the explanation of the discrepancies in their electric bills as they moved from town to town.

BUT what the Browns and the Smiths discovered was that no matter where they went in these United States, electricity followed the flag. In other words, the Browns, for their average annual outlay of $19.20, commanded anywhere in the land the services of hydro plants, steam plants, far-flung transmission lines, the dams across mighty rivers, the networks of cable laced across rural skies or beneath city asphalt, all worth $12,900,000,000. Just the dams, plants and dynamos awaiting Mrs. Brown's command to begin to heat up her electric iron, so that she could go to work on Mr. Brown's boiled shirt, cost more than all the income of all the life insurance companies in the United States in 1929. Just the transmission lines, the substations and the poles and wires constituting the interconnections between generating stations and the ice cubes in Mrs. Smith's refrigerator cost a sum of money equal to 40 per cent of all the savings deposits in all the state banks in 1929. Yet it was all at the beck and call of Mr. and Mrs. Smith for a whole year at this national average figure for 3,000 kilowatt-hours of $67.56, and it was all available to Mr. and Mrs. Brown, with their more modest tastes, at the national average figure for 240 kilowatt-hours of $19.20.

WHEN you can have the use of nearly thirteen billion dollars worth of property anywhere in the United States for $67.56 a year it began to look to Mr. and Mrs. Smith, who were typical sensible Americans, as though "share-the-wealth" was actually already here. At least it looked as though somebody had already put into effect the slogan, "Share the Electric Light Company."

"For suppose," said Mr. Smith, "we really had some kind of 'share-the-wealth' business. That would mean we'd have to share the electric light company, too, wouldn't it?"

"I imagine it would," said Mrs. Smith.

"Well, what would they do?" inquired Mr. Smith. "Would they divide it all up? What would we get if they did? I suppose we'd get forty feet of wire, a few nuts and bolts from the Watkins Street power house, a

[*Continued on page 100*]

ELECTRICAL WORLD

L. W. W. MORROW · EDITOR

PUBLISHED EVERY OTHER SATURDAY BY McGRAW-HILL PUBLISHING COMPANY, INC.

VOLUME 105 ESTABLISHED 1874 NUMBER 17

AUGUST 17, 1935

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Diminishing Returns from Political Attacks

RECENT events in Congress reveal the potency of the investor who is also a voter in protesting against the threatened destruction of his or her savings by bad legislation. Political mathematics is filled with unknown quantities, but when constituents make themselves heard by the thousand a lot of x's are projected in the Congressional imagination into small squares provided on future ballots. Such cross-sections of public opinion are extremely significant, and when raised to their full power are capable of changing the course of political and economic history.

Good service is a major objective of the power industry, so widely maintained that it is practically invulnerable politically. Popular misunderstandings as to rates are rapidly being dissipated. As the people become more and more tax-conscious, the importance of existing utility levies to aid the public treasury is being driven home. It is becoming harder and harder to deceive the public about the alleged economies of governmental enterprises in the power field, whether sought in the murky atmosphere of municipal politics or in the grandiose airs of T.V.A. and Quoddy.

The impact of the recent anti-New Deal decisions of the Supreme Court is still vibrating throughout the nation, arousing public opinion to the dangers of autocracy and regimentation. Attacks on size as such and under guise of "protection" for the investor and utility customer are losing force in the face of the doubtful constitutionality of proposed legislation to "soak" the thrifty. Finally, the fighting power of an aroused industry, embattled for its fundamental rights and supported by a widespread demand on the part of customer and citizen owners for a square deal, is winning respect all over the land. As the facts about the utilities become known and the opponents of their persecution unite their forces, the rewards of political attack begin to take wing. Abuse reacts upon those who rashly resort to it, and on the day when the demagogues sense that destructive assaults on their constituents' interests have become unpopular, this sort of corporation baiting will go into the red as a source of political livelihood.

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Buy It, Don't Make It

ENGINEERS are always seeking to develop a new device or an improvement on an old device. When this is done they wish to have it made and put to work. They have little knowledge of the cost of manufacture or of the commercial problems introduced by changing designs or introducing a new product. Naturally enough, at times these engineers attempt to go into the manufacturing business themselves, and this raises questions of policy between industry groups. Utility engineers are prone to manufacture equipment either on a subsidized basis from their local utility company or as a side activity on their own time. Of course, manufacturers of established reputation object to this practice and say that utilities, as a policy, should not permit their employees to engage in electrical manufacture. Based upon the experience of the past, it is good policy to limit the functional operations of the several branches of the industry. Electrical manufacturers have always gone hand in hand with the utilities in the development of new and improved products and can be counted upon to continue this policy. Manufacturing is their function in the industry. It is a waste as well as a bad policy for utilities or their employees to engage in manufacturing, even though an individual case might be justified on the basis of temporary economic merit.

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Let's Build Those Rural Lines

THOUGH Congressmen may rave at the idea of the Rural Electrification Administration loaning money to the private utilities—and perhaps prevent it—the common sense of Morris L. Cooke's approach to the problem of rural electrification will appeal to the American people. He sought the advice of a committee of the men who know the most about it. It is common practice in business, though unhappily too uncommon in politics. And it has gone far toward visualizing the immediate opportunity for development in the rural areas, no matter what the government may do about it.

If there are 78,180 miles of power lines said to be worth building, at a cost of $75,320,000 for construction and $38,365,000 for meters, transformers and services, here is the way this federal appropriation should be expended, if the greatest permanent benefit is to be given. And the establishment of a governmental agency for the financing of domestic equipment for households that have been heretofore denied the

benefits of electric service should be part of the plan. For these new rural lines will require $79,418,000 for appliances, $41,295,000 for house wiring and $3,851,000 for service extensions, according to the committee, and the key to this market will be easy payments.

One of the valuable things that has been learned in this depression—now fast waning, Heaven be praised!—is the security of time-payment sales. Except during the early days of panic, people have made their payments. Losses have been negligible. And sales have been made that would have been otherwise impossible. For the modern John and Mary like to buy that way.

So as long as Uncle Sam is in the loaning business, let's build those rural lines—with federal funds or not—and utilize federal financing to load the circuits and make them pay. There may never come another opportunity so favorable for extending electric service rapidly to those 66,000 isolated families.

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The Real Foundation of Good Selling

IN THE beginning electrical engineering was all experimental. Present efficiencies have come as a result of years of observations and studies made to determine the accuracy of theories and practices. And so it will be some day with selling. There will be enough recorded experience to indicate clearly how a power company should sell its service and what it should cost to build domestic, commercial or industrial load. It will be no longer a matter of local opinion.

Selling is, of course, subject to all the vagaries of human nature—both in the salesman and the customer. But, nevertheless, it consists of many definite factors. The selection, education and training of sales personnel, the development of an effective sales presentation, the establishment of specific sales territories and performance quotas, the compensation of salesmen on an incentive basis, the direction of sales effort, the analysis of potential markets and the maintenance of sales control records are all features of management which may be organized on the basis of exact knowledge. The education of customers, the promotion of good will, the building up of trade co-operation, the creation of local demand and the development of larger revenue and earnings are the products of such management. And results are good or poor according to the methods used.

To meet the need for larger load per customer to carry lower rates and higher costs, the industry looks today to better selling, and it will come—is seen already all about us. But better selling must mean more than drumming up all employee enthusiasm and high-pressuring appliances into homes with bargain offers. This is all right in an emergency and may have its place in any sound plan. On the long pull, however, it is going to get down to intelligent organization and control of adequate appropriations and man-power. Then commercial effort becomes effective and efficient.

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The Ultimate in Steel Tower Transmission

HIGHEST in voltage, the world's longest straightaway transmission line could not be designed and erected across desert, torrential and mountainous areas without encountering and overcoming a host of new problems. Their solutions in connection with the Boulder Dam development constitute the major instance of advanced technique in a multiplicity of departments of power handling during the recent few years of construction dormancy. In several respects the engineering details set new goals for other lines. Nevertheless, the voltage level, the distance and the magnitude are not likely to be duplicated for some time. In fact, it will take a radical departure in transmission technique to justify even an approach to a duplication of this job.

Choice of voltage on economic grounds demanded a conductor that would meet mechanical and electrical requirements as well as conform to acceptable corona behavior. The conductor selected, a pioneer installation in this country, showed a one-eighth saving in tower and supports along with the requisite corona performance. With it goes a new design of slender-waisted tower with skewed base and a new style of clamp with free center to deal with the vibration-fatigue problem. Insulation could not be viewed as simple extrapolation from familiar 220-kv. levels. Protection had to be superlative, and one aspect of this is the "encasing" of the line in a shield consisting of two overhead ground wires and a diamond-shaped buried counterpoise.

Stable operation under transient conditions presented a critical problem, but higher-speed relaying and quicker breaker action contributed to the escape from this obstacle. Carrier is used not only for the relaying but for supervisory control, communication and for calling all patrol cars. Particular phase wires are assigned for these respective carrier functions.

Without enumerating further, it is evident that most of the advances might have waited longer for development had not this large-scale opportunity been afforded to subsidize their cost. Now that they are individually available they can be adapted to projects of lesser magnitude and to lines of the voltages which are more firmly established. Whether these Western lines will behave as expected in avoiding outage and earning their keep remains to be seen, but there is no doubt about the new tools they have afforded to transmission engineering.

NEWS OF THE INDUSTRY

R.E.A. Loan Terms Set by Roosevelt

Private and public organizations assured government money at 3 per cent — Loans, not grants, provided for — Rankin and Norris oppose government financing private utilities

President Roosevelt issued an executive order on August 7 prescribing rules and regulations under which the Rural Electrification Administration may make loans for power and light projects in rural areas now without electric service. Loans to public and private agencies for rural electrification projects are permitted under the rules and regulations prescribed.

Not less than 25 per cent of the entire expenditure upon projects under any loan for an electrification project made to a public body under the law must be expended for labor. R.E.A. expects that the expenditure for labor will exceed this, the proportion varying somewhat with the section of the country. While this provision, under the law, is limited to loans made to public bodies, it is believed that the proportionate outlay for labor on the projects of private utility companies, associations and cooperative organizations will be about the same.

Wage rates for persons employed on projects except for supervisory administrative and highly skilled employees will be determined or approved by R.E.A. "in accordance with local wage conditions."

No provision for grants

The regulations make no provision for grants. Accordingly, R.E.A. will make funds available for project construction, out of the $100,000,000 designated by Congress for rural electrification, exclusively in the form of loans. Loans may be made, however, for the entire cost of projects.

Although about 95 per cent of the electric utility industry in the United States is privately operated, there will not be a corresponding division beforehand of R.E.A. funds. There will be no arbitrary division whatever, according to the statement issued by R.E.A. Funds will be made available to public and private agencies in whatever proportions each group submits sound projects and submits them promptly. A preference will be accorded, as previously announced, to the applications of public bodies and farm cooperatives. Whatever the amount of loans R.E.A. may make for the construction program recently proposed by the private utilities (ELECTRICAL WORLD, August 3, page 44), ample provision will be made for the financing of projects sponsored by public bodies and by farm cooperatives. To this end additional funds will be provided, if necessary, to assure adequate financing for both the public and the private projects.

Congressional opposition

Representative John E. Rankin of Mississippi announced that he was unalterably opposed to the lending of government funds to private utilities for the extension of rural electrification. Maintaining that the majority of private operating companies are owned and controlled by holding companies, he said: "We might as well make a contribution to the power trust and be done with it."

Senator Norris said he would oppose any loans to private utility companies from the government's $100,000,000 funds for rural electrification. "I am wondering why the government of the United States should loan money to companies doing what the private power companies are doing," Senator Norris said. "I don't see any reason to loan them money to continue their nefarious conduct against any municipality that wants to put up a municipal electric system . . . The Alabama Power Company goes to court to prevent public power development at Florence. Why should the government then turn around and lend money to the Alabama Power Company to develop lines in that same territory."

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Recommendations to Be Made Soon on Passamaquoddy

An Army engineering staff in consultation with Dexter P. Cooper is busy with preliminary studies of the Passamaquoddy project. It is hoped to make preliminary recommendations shortly, but site borings must be taken and details of design worked out before final recommendations can be made. Bids on the boring work have been called and an emergency contract will be let. The general plan of Mr. Cooper is being followed, but important changes may be made in regard to the location and types of structures.

Preliminary estimates are for the production of 250,000,000 kw.-hr. a year, but these wait final determination. Studies are made of the use of a design to use a change in the direction of water if it is determined to use high and low level pools as well as the relative merits of the several types of turbines and power house structures. At present the Army engineers are not in position to make definite recommendations because of lack of data.

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P.W.A. Forms Power Division; Ross Named Consultant

Application for P.W.A. funds for publicly owned power plants is to be expedited. Orders have been given to all P.W.A. state offices to give preference to this class of applications and, in addition, a power division has been created within the Public Works Administration to have jurisdiction over all power projects from the time they are received by the state directors until finally acted upon. The present system of field examination will be continued unless it appears impossible for the state offices to complete these studies within a reasonable time, in which case they are to be referred directly to the power division.

J. D. Ross, superintendent of the Seattle municipal power plant, has been appointed chief consulting engineer of the power division and will assume his duties in Washington next week. Other appointments to the division set-up, under direction of Dr. Clark Foreman, include Samuel Becker, formerly P.W.A. attorney in Wisconsin, to head the legal division, and K. Sewell Wingfield, as assistant director of the power division. Mr. Wingfield was transferred from P.W.A.'s finance division. Administrator Ickes expressed gratification that P.W.A. has been able to obtain Mr. Ross's services and said that he will proceed rapidly with examination of project applications submitted by local governments.

Recent P.W.A. allotments include: $197,000 to Delta, Colo., for a steam-electric plant and purchase of the distribution system of Western Colorado Power Company; $212,000 to Pauls Valley, Okla., for a steam-electric plant and distribution system; $112,500 to Lubbock, Tex., for an addition to its present plant; $120,450 to Phillipsburg, Kan., for a Diesel-electric plant and distribution system, and $65,000 to Wynnewood, Okla., for a Diesel-electric plant.

Hopson Refuses to Reveal Income to House Lobby Investigators

Associated executive traces history of system — Admits he got $100,000 in 1922 — Declines to discuss personal service companies — Summoned before Senate — Conferees discuss death sentence

Sought for weeks in the investigation of the campaign against the Wheeler-Rayburn bill, Howard C. Hopson, reputedly the dominant figure in the Associated Gas & Electric Company, appeared before the House investigating committee this week and discussed in detail the part he played in building up the complicated Associated system. Mr. Hopson testified that the purpose in acquiring 300 companies since 1922 was to insure operating economies, which could be "passed on to consumers in lower rates and to insure dividend and interest payments to investors who put up their money."

Income query resented

Upon being interrogated as to the source of his income, Mr. Hopson said: "Mange (J. A. Mange, president of the Associated Gas & Electric Company), received a salary from Associated and my source was from carrying on my personal business." He said in 1922 his income was about $100,000, but he did not recall his present income. "The Constitution guarantees my privacy. I'm engaged in business of trying to build up the sales of gas and electricity," he stated. Mr. Hopson repeatedly refused to answer questions about his personal income and his personal service companies.

He testified that he first became identified with Associated in 1922. The company at that time was under the management of the J. G. White Management Corporation. Mr. Hopson said he was retained to carry out consolidations, supervise tax work and generally help in running the several groups managed by the White corporation. He told of gradually building up the system through acquisition of small utility companies and estimated gross earnings of the Associated System at $100,000,000 annually. He said that when the company was first taken up by his management its credit was bad and its securities sold at $9 a share.

The Associated Gas & Electric Company, the parent holding company, he said has been in existence since 1906, and the Associated Securities Corporation was set up by Mr. Mange, who had been a vice-president of the White organization, and himself as a convenience in keeping their personal accounts and books straight. Later the Pennsylvania Public Service System was acquired at a cost of $17,500,000.

John J. O'Connor, chairman of the House committee, turned to a suit now pending in New York State to put one of the Associated companies in bankruptcy. "It's foolishness," Mr. Hopson retorted. "There isn't a single judgment against us. The company is perfectly healthy."

Mr. Hopson said the Associated had expended between $800,000 and $900,000 in fighting the Wheeler-Rayburn bill, adding that it is possible that the company may spend a great deal more. He was cited by the SesnateETAOINETAOIN cited by the Senate to show cause why he should not be held in contempt because of his failure to obey a subpœna to appear before the investigating committee.

Last week the Senate committee heard the testimony of Patrick J. Hurley, Secretary of War in the Hoover Administration, and Joseph P. Tumulty, who was Secretary to President Wilson. Both witnesses acknowledged their employment as counsel for public utility holding companies in connection with the holding company bill, but said their activities had been confined to legal services. Both denied ever lobbying for or against any phases of the measure.

J. F. Fogarty, president of the North American Company, has advised security holders that the company had filed with Senator Black, chairman of the Senate investigating committee, a sworn statement putting the expenditures in connection with the Wheeler-Rayburn bill at $49,865. The statement was filed in answer to the committee's questionnaire and shows expenditures by all companies in the utility group.

Possibilities of deadlock on bill

In the meantime, after the House of Representatives had again turned down the proposed death sentence clause in the holding company bill by a vote of 209 to 155 and after Benjamin V. Cohen and Dozier Devane, whose presence in the conference room was largely responsible for the deadlock, were barred, the Senate and House conferees finally met to give real consideration to the legislation. The "death clause" was reached this week, but no specific proposition has been determined upon.

Willkie Talks Frankly

As to the so-called lobbying activities, this corporation did not spend one cent in any unethical or improper way or seek to influence, except by logic and facts, any Congressman, and it condemns both lobbying and undue influence when practiced by either the representatives of the federal Administration or of utilities. We conducted an open and frank campaign, which we hope was intelligent and constructive, to offset the Administration's two years of highly colored and unfair propaganda against utility companies and the political pressure of its $4,800,000,000 relief funds and control over federal patronage.

We know passage of this bill will entail great financial loss to our security holders, further retard the economic recovery of the nation by its deflationary aspects and cause the second largest industry in the United States to be unable, until there may be a decision by the courts, to render the almost immeasurable service which it can render to the relief of unemployment in construction and other business activities.—*Letter to stockholders from*

WENDELL L. WILLKIE,
President Commonwealth & Southern Corporation.

E.H.F.A. Reorganized on National Basis

Separated from T.V.A. to assist R.E.A. — Cooke will direct activities — Headquarters moved to Washington — Appliance list considerably enlarged

Electric Home and Farm Authority, Inc., T.V.A.'s auxiliary organization formed to push the sale of electric refrigerators, water heaters, ranges and pumps, is being reorganized on a national basis to help R.E.A. The original Delaware corporation, of which David E. Lilienthal was president and A. E. Morgan and H. A. Morgan were directors, is being dissolved and a new E.H.F.A. incorporated in the District of Columbia with a directorate composed of Morris L. Cooke, head of R.E.A., and seven officials of the Reconstruction Finance Corporation. Mr. Cooke will also be president. Headquarters will be moved from Chattanooga, Tenn., to Washington.

Financed sales totaling $465,290

Besides extending its field of operations to include the entire country, rural and urban, E.H.F.A. plans to enlarge the list of appliances which it will finance to include all kinds of electrical farm equipment and plumbing supplies used in connection therewith. No sales will be made direct; the corporation will function by buying from the usual sales agencies the customers' notes extending over periods of from four to seven years, depending upon the amount and type of equipment purchased.

During the first half of 1935 E.H.F.A. financed sales of $465,290 to 8,296 customers in Alabama, Mississippi and Tennessee, an average of $56 per family. Extending this to the entire country, it forecasts a potential sales volume of $1,250,000,000. It is believed that expansion of E.H.F.A. is the first indication of a government drive to encourage installment sales in many fields by the reduction of interest rates through the efforts of government agencies directly or by loaning low-cost funds to private financing companies.

Under the new charter the old E.H.F.A. powers to manufacture, distribute and sell are greatly restricted. The new corporation is strictly a discount agency following the pattern of the direct-loans-to-industry section of the R.F.C. extension act. Although capitalized at only $850,000, it will be eligible to receive almost unlimited loans from R.F.C.

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New F.H.A. Ruling

The dollar-pulling appeal of F.H.A.'s home modernization campaign for department stores and other retail outlets was greatly enhanced by a recent ruling to the effect that installation of several heavy-selling types of household equipment doesn't have to be permanent. Included are all types of refrigerators, electric and gas ranges, coal ranges, electric washing machines, ironers, unit air conditioning.

Much of this equipment, particularly refrigerators, has been selling in large volume on F.H.A.'s credit terms, with proper attention to the detail of permanent attachment. The list cannot be stretched to cover small gadgets such as mixers, fans, toasters, irons and egg beaters, but an amazing variety of other household equipment is being sold on F.H.A.'s time-payment insured credit plan, under which the local bank advances the money and makes the collections.

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Alabama Power Wins T.V.A. Case; Conferees Hit Snag

A victory was won by the Alabama Power Company over the Tennessee Valley Authority in the District of Columbia Supreme Court when Justice F. Dickinson Letts issued a preliminary injunction preventing P.W.A. from loaning funds to four Alabama cities for municipal power systems to handle T.V.A. energy. This injunction confirms a restraining order granted previously by Justice Luhring of the District of Columbia Supreme Court (ELECTRICAL WORLD, August 3, page 46).

Senate-House members of the conference committee on the T.V.A. bill ran into sharp conflict this week on two major provisions and passed them over for consideration later. They are the Senate provisions for increasing the bonding limit of the authority from $50,000,000 to $100,000,000 and for allowing purchase of distributing systems in the Tennessee Valley area.

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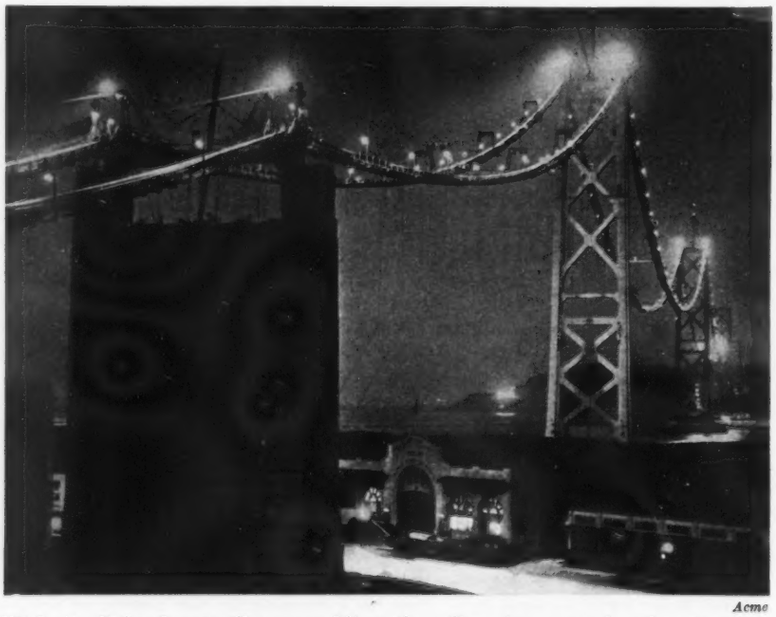
Sodium Lights to Illuminate San Francisco Bridge

The largest and most spectacular installation of sodium lighting in the world will provide more than eight million lumens of that new golden yellow illumination for the San Francisco-Oakland Bay bridge upon its completion, according to General Electric engineers, designers of the sodium-light equipment.

A total of 922 G.E. "Novalux" sodium luminaires will be supplied and will be used in 25 circuits strung along about 15 miles of roadways for the double-deck spans, the tunnel and the approaches comprising the huge new link between San Francisco and Oakland. On the upper deck of the bridges to be used for passenger vehicles and other high-speed traffic 6,720,000 lumens of 10,000-lumen sodium lamps will be installed, while 1,500,000 lumens of 6,000-lumen lamps will be used on the lower deck of the bridge for trucks and similar lower-speed traffic.

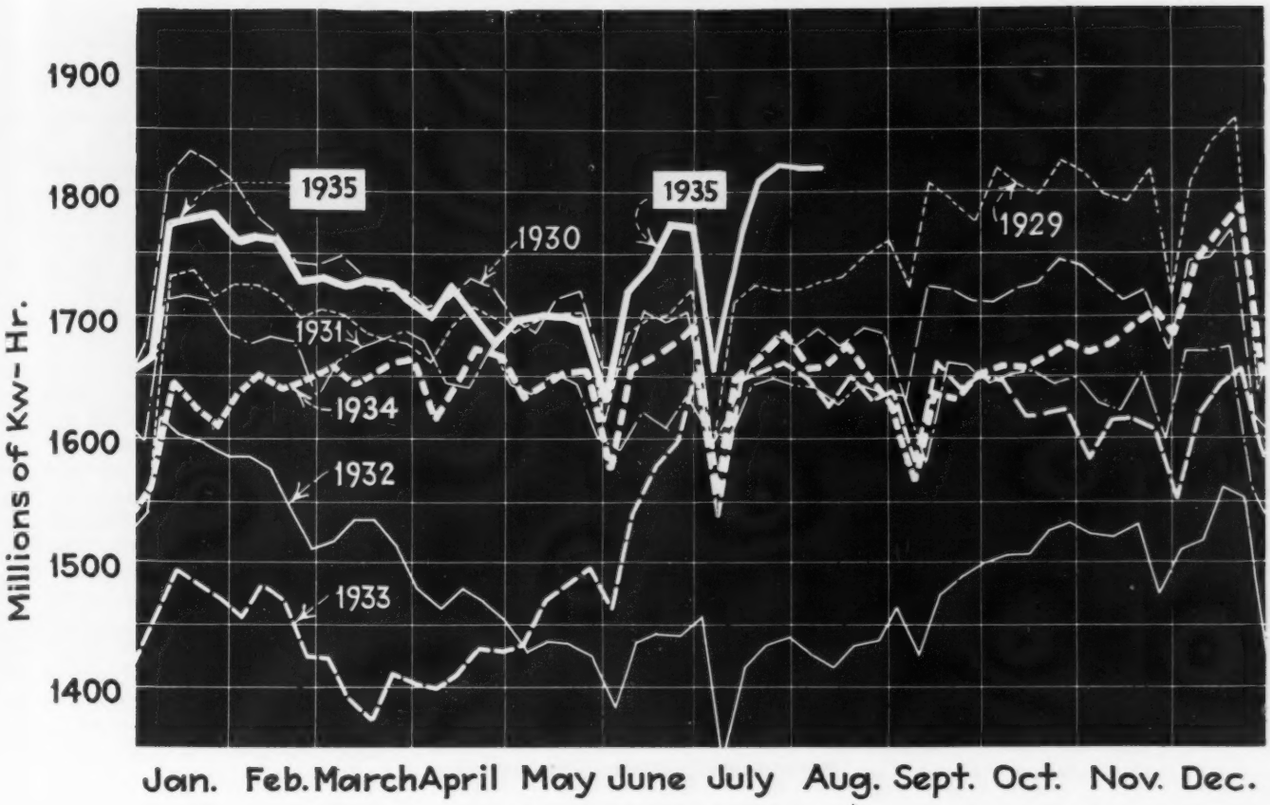
BRIDGE NOCTURNE



Acme

With its lighted catwalks resembling the glistening strands of a jeweled necklace, this new bridge linking San Francisco and Oakland is being built by the State Department of Public Works at a cost of $77,600,000. The most spectacular installation of sodium lighting in the world will be provided, according to General Electric engineers, designers of the sodium-light equipment.

Output Shows Marked Gain



Continuing to hold the high excess over August of the peak year of 1929, electric energy output for the week ending August 3 was reported by the Edison Electric Institute as 1,821,398,000 kw.-hr., which is 5.5 per cent above the record for the same week of 1929. In addition, output for this same week showed an increase of 9.9 per cent over the corresponding week last year. This is the highest gain for the year with the exception of January 26, when the gain was 10.6 per cent.

Large gains in output made during June and July seem little affected to date by the general lull in business activity usually occurring during August. Continued heavy gains over 1934 in the Mountain states reflects increased activity in mining of metals. Last week's gains of more than 10 per cent over 1934 in the Central Industrial and West Central regions seem to point to increased demands for automotive, steel and agricultural machinery manufacture—this gain being the largest in these sections since last winter.

Weekly Output, Millions of Kw.-Hr.

1935	1934	1933
Aug. 10...1,819	Aug. 11...1,659	Aug. 12...1,627
Aug. 3...1,821	Aug. 4...1,658	Aug. 5...1,650
July 27...1,824	July 28...1,684	July 29...1,662
July 23...1,807	July 21...1,664	July 22...1,654
July 13...1,766	July 14...1,648	July 15...1,648
July 6...1,655	July 7...1,556	July 8...1,539

Per Cent Change from Previous Year

Region	Week ended Aug. 10	Aug. 3	July 27
New England	+ 7.3	+ 8.4	+ 6.7
Middle Atlantic	+ 7.2	+ 7.5	+ 8.5
Central Industrial	+ 9.8	+10.4	+ 7.2
West Central	+10.3	+11.7	+ 9.3
Southern States	+10.4	+11.7	+ 7.6
Rocky Mountain	+37.0	+33.3	+33.7
Pacific Coast	+ 5.5	+ 4.8	+ 5.4
United States	+ 9.7	+ 9.9	+ 8.3

New Record for June Output

Energy output of public utility power plants during the first six months of 1935 was 5.5 per cent greater than in the like period of 1934, according to the U. S. Geological Survey, which announces a total of 47,564,000,000 kw.-hr. for the half year. The total was slightly greater than in the first half of 1929, the year of maximum production. Output in June was 7,872,000,000 kw.-hr., or 5 per cent more than last year and 1 per cent above the previous maximum for the month, but the daily average decreased by approximately the usual amount compared with May.

Production from water power continues to be large. In June it amounted to 3,450,000,000 kw.-hr., or 44 per cent of the total, but the average daily production from this source was somewhat less than the record output for May, owing to the usual seasonal decrease in the flow of streams utilized for power.

Exceptional gains over 1934 occurred in the Rocky Mountain, East South Central and West North Central regions, with moderate recessions in two others, as the table shows.

	Mar.	April	May	June
United States	+ 4	+ 5	+ 4	+ 5
New England	+ 3	+ 5	+ 3	+ 8
Middle Atlantic	— 1	+ 3	+ 3	+ 4
East No. Central	+ 2	+ 6	+ 3	— 3
West No. Central	+17	+21	+15	+18
South Atlantic	+ 6	+ 4	+ 7	0
East So. Central	+14	+ 9	+ 4	+28
West So. Central	+ 7	+ 9	+ 5	— 2
Mountain	+10	+12	+15	+34
Pacific	+ 1	— 6	— 2	+ 7

Power Industry Adds Large Commercial Users

Announcement has been made by the Edison Electric Institute that the electric light and power industry added 5,522 new large commercial customers to the lines during the month of June. This compares with a gain of 2,620 large consumers of power during the month of May, prior to which the industry had been losing large consuming customers since October. The number of large commercial customers as of June 30, 1935, was 505,135, against 499,583 in May and 530,976 on October 31 last. As of June 30 last year the number was 527,432. It is believed that further gains were made in July.

California Utilities Valued at Billion

California State Board of Equalization has completed its first assessment of the properties of the California privately owned public utility corporations being returned from the state to the county tax rolls and announced the holdings have been valued at $1,045,839,570. As the board began hearings of protests by the utility corporations against the assessments, it listed tangible property of the public service companies at $900,835,435 and gave money and intangibles as $145,004,135. The figures are the result of months of research by the board's valuation division under the direction of A. G. Mott.

The board stated that the addition of the utility holdings to the common property of the state will boost the local tax rolls to $6,614,797,120, marking an average increase of more than 15 per cent in the value of property subject to local taxes.

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Lower Colorado Contracts Signed by Government

Contracts have been signed by the government and the Lower Colorado River Authority clearing the way for construction of the $20,000,000 Lower Colorado River project in Texas. One contract, between P.W.A. and the authority, provides for the purchase by the government of not to exceed $10,500,000 revenue bonds of the authority and a grant of 30 per cent of the cost of labor and material used, but not to exceed $4,500,000. A second agreement, between the Secretary of the Interior and the authority, covers an additional $5,000,000 to be spent on the project by the Bureau of Reclamation on flood control and irrigation phases involved.

The project involves the completion of a dam near Bluffton, Tex., and the construction of a unified system of new dams and reservoirs that will provide flood control, hydro-electric power production and water storage for the irrigation of about 120,000 acres of rice land located 90 miles downstream from Austin. Revenue from power and water sales is expected to repay the cost of the project.

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Engineers Discuss Taxation

The fifth annual Economics Conference for Engineers opened this week at the engineering camp of the Stevens Institute of Technology at Johnsonburg, N. J., with an attendance of approximately 125 graduate engineers. It was devoted this year to taxation and the cost of government. Dr. W. D. Ennis, professor of the economics of engineering and director of the conference, presided at the first session, leading a discussion of the place of the engineer in an expanding government economy. Dr. Ennis stated that there would be an increasing demand for the economist-engineer for work on regulatory bodies. "The engineer," he said, "if he is to adapt himself to new conditions, must increase his knowledge of currency, finance and taxation and even of rural economics. In the field of city planning, for instance, the work is 20 per cent engineering, 30 per cent economics and 50 per cent legal. The average young engineer has heretofore avoided political activities and the best of them have preferred almost anything else to government service of any type."

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World Power Conference Bill Passed by House

By a vote of 234 to 92 a bill authorizing the President to invite the World Power Conference to hold its session in this country next year was passed this week by the House of Representatives. The measure, which also authorizes the chief executive to supply $75,000 for expenses, was sent to the Senate.

COMING MEETINGS

American Foundrymen's Association—Annual convention, Toronto, Canada, August 20-23.

American Institute of Electrical Engineers — Pacific Coast convention, Seattle, Wash., August 27-30. Great Lakes District meeting, Purdue University, West Lafayette, Ind., October 24-25, H. H. Henline, national secretary, 33 West 39th Street, New York.

Illuminating Engineering Society—Annual meeting, Hotel Netherlands Plaza, Cincinnati, Ohio, September 3-6. D. W. Atwater, general secretary, 29 West 39th Street, New York.

National Electrical and Radio Exposition — Grand Central Palace, New York, N. Y., September 18-28.

International Association of Electrical Inspectors — Northwestern section, Seattle, Wash., September 3-5; Southwestern section, San Diego, Calif., September 10-12; Western section, St. Louis, Mo., September 16-18; Southern section, Asheville, N. C., September 30-October 2; Eastern section, Boston, Mass., October 7-10. Victor H. Tousley, secretary-treasurer, 612 N. Michigan Avenue, Chicago, Ill.

National Electrical Manufacturers Association—Annual meeting, Palmer House, Chicago, Ill., October 7-11. W. J. Donald, 155 East 44th Street, New York.

Electrochemical Society—Fall meeting, Washington, D. C., October 10-12. Colin G. Fink, secretary, Columbia University, New York.

National Association of Railroad and Utilities Commissioners—Annual convention, Nashville, N. C., October 15-18. John E. Benton, general solicitor, 806 Earle Building, Washington, D. C.

National Electrical Wholesalers' Association—Annual convention, Chicago, Ill., October 14-18. E. Donald Tolles, managing director, 165 Broadway, New York.

Insull Stock Bought In; $21,000 Pension Restored

The General Electric Company has bought in for $39 a share 390 shares of Peoples Gas Light & Coke common stock and for $82 a share 691 common shares of Commonwealth Edison Company, representing part of the collateral securing loans made in 1931 to Insull companies. The sale concluded the present series of auctions of Insull collateral held by New York lenders. Several New York banking institutions have not yet set dates for auctions of their collateral.

Restoration of Samuel Insull's $21,000 annual pension has been voted by the directors of the four Chicago companies which he formerly headed. They are Commonwealth Edison, Public Service Company of Northern Illinois, Peoples Gas Light & Coke Company and the Peoples Gas subsidiary corporation. Mr. Insull will receive about $33,250 in a lump sum to cover payments accruing since the beginning of last year, when the payments were suspended by the companies. Agitation to restore the pension was begun after Mr. Insull had been freed in the federal and state courts of criminal charges growing out of his management of the utility properties.

Improved earnings, both for the Middle West Utilities Company and its subsidiaries, were announced by Daniel C. Green, trustee for the parent company, in a recent report to Federal Judge James H. Wilkerson, before whom reorganization proceedings are pending.

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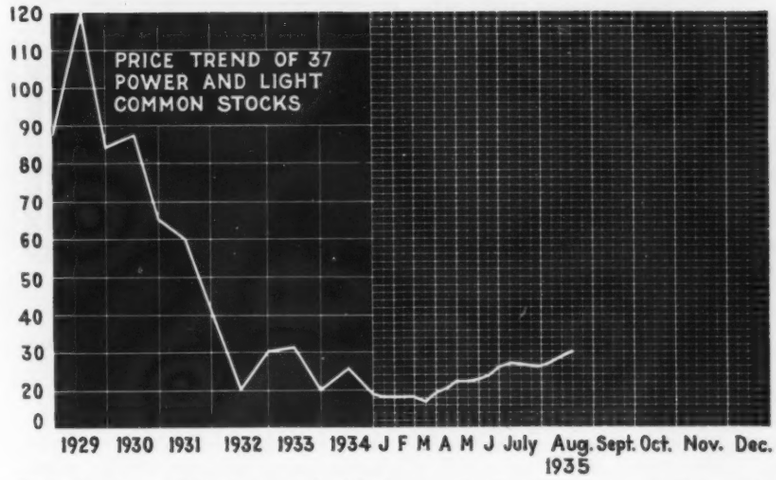
Merger Effected by New York Edison

Following the formal approval of the state Public Service Commission (ELECTRICAL WORLD, August 3, page 48), the New York Edison Company, Inc., has come into existence as a result of a consolidation of the New York Edison Company and the United Electric Light & Power Company.

The company has been authorized by the commission to issue 5,313,999 shares of common capital stock without par value, of which 5,313,997 are to be issued to the Consolidated Gas Company of New York upon the surrender of a similar number of shares of stock of the New York Edison Company, and two shares issued of record in the name of the treasurer of the New York Edison Company, Inc. Consolidated Gas has been authorized to acquire and hold the 5,313,997 shares of common stock of the New York Edison Company, Inc.

After the organization meeting, Floyd L. Carlisle, chairman of the Consolidated Gas board, said that the consolidation would in no way affect the relations existing between customers and the company.

Utility Stocks Advance Sharply



With the fear of detrimental legislation gradually dissipating, utility stocks moved in new high ground this week. "Electrical World" index, 30.8, the highest point since July, 1933; last week, 28.9.

New Utility Issues

A new issue of $5,400,000 Public Service Company of New Hampshire 4 per cent refunding bonds will reach the investment market next week. Application was filed with the Securities and Exchange Commission on August 2. Proceeds, together with company funds, will be used to redeem on October 1 5 per cent first and refunding bonds, series A, which are outstanding to the amount of $5,400,000.

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June Refrigerator Sales

Sales of household refrigerators in June totaled 159,167 units valued at $12,086,349, according to statistics released last week by the National Electrical Manufacturers' Association. The figures covered reports from fourteen companies. The total represents 146,988 refrigerators sold in the domestic market and 12,179 shipped abroad. Sales for the first six months of this year were well ahead of the corresponding period of 1934, reaching 1,071,754 units valued at $82,452,696 this year, as against 891,837 units valued at $75,247,457 last year.

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Square D Plans to Pay Accrued Dividends

The Square D Company contemplates submitting to stockholders soon a plan covering the payment of accrued dividends on its class A preferred stock. The accrued dividends, as of June 30, 1935, amounted to $6.87½ a share on 99,969 shares of class A preferred stock outstanding. Class A preferred stockholders are to receive the dividend accumulation to June 30, 1935, a stock dividend of class A preferred equal to 23 1/3 per cent of shares held, or one share of class A preferred for each $29.50 of accrued dividends. The dividend stock is to be the same as the class A preferred outstanding.

N.E.M.A. Committees to Co-operate With NRA

Two committees have been appointed by the National Electrical Manufacturers' Association to co-operate with the Division of Review of NRA, one to co-operate on an analysis of the code history and experience of the electrical manufacturing industry and the other to co-operate in an objective study of open price filing experience under the electrical manufacturing industry code.

A committee of the officers of N.E.M.A. will co-operate on the industry study and the committee on the open price filing study will consist of Frank C. Jones, president of N.E.M.A. and president of the Okonite Company; Clarence L. Collens, Reliance Electric & Engineering Company; Robert Edwards, Edwards & Company; S. L. Nicholson, Westinghouse Electric & Manufacturing Company, and B. M. Tassie, Manning Bowman & Company.

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Blaw-Knox Net Increases

For the six months ended June 30 Blaw-Knox Company reports net profit, after interest, depreciation, federal taxes and other charges, totaled $301,448, equal to 22 cents a share on 1,322,395 no-par capital shares, compared with $105,214, or 8 cents a share, for similar 1934 period.

Current Earnings Reports

Operating Companies

	1935	1934
Alabama Power (Year to June 30)		
Gross earnings	$15,960,230	$15,698,975
Net balance	647,741	619,748
Consol. G. E. L. & P. Co., Baltimore (Year ended June 30)		
Gross earnings	29,676,492	28,373,562
Net balance	4,797,547	4,866,159
Consumers Power (Year to June 30)		
Gross earnings	29,067,896	27,531,655
Net balance	3,201,766	3,259,094
Georgia Power (Year to June 30)		
Gross earnings	22,659,542	22,264,290
Net balance	1,305,739	1,491,168
New Orleans Pub. Serv. (Year ended June 30)		
Gross earnings	15,115,537	14,985,400
Net balance	211,405*	170,255*
Ohio Edison (Year to June 30)		
Gross earnings	15,529,557	14,950,967
Net balance	1,404,285	1,355,308
Penn. Pwr. & Lt. (Year ended June 30)		
Gross earnings	34,375,194	33,664,062
Net balance	4,712,269	5,453,847
Philadelphia Elec. (6 mos. ended June 30)		
Gross earnings†	32,588,259	31,804,910
Net balance	9,798,917	10,442,539
Southern Cal. Edison (Year ended June 30)		
Gross earnings	36,425,447	35,787,855
Net balance‡	10,942,741	10,606,194
Tenn. Elec. Pwr. (Year to June 30)		
Gross earnings	12,629,925	12,079,424
Net balance	340,671	490,772

Holding Companies

	1935	1934
American Pwr. & Lt. & subs. (Year ended June 30)		
Gross earnings	$79,554,745	$74,178,210
Net balance	5,911,340	3,344,657
Commonwealth & Southern & subs. (Year ended June 30)		
Gross earnings	117,266,287	112,892,655
Net balance	977,670*	393,871*
Electric Pwr. & Lt. & subs. (Year ended June 30)		
Gross earnings	75,920,181	71,163,289
Net balance	222,218*	790,543*
Mohawk Hudson Pwr. & subs. (Year ended June 30)		
Gross earnings	38,734,907	36,751,137
Net balance	3,169,867	3,963,111¶
National Pwr. & Lt. & subs. (Year ended June 30)		
Gross earnings	71,776,324	70,547,477
Net balance	6,161,245	6,815,078
North American & subs. (Year to June 30)		
Gross earnings	108,710,520	107,178,046
Net balance	9,750,505	8,893,015
Public Service of N. J. & subs. (Year ending June 30)		
Gross earnings	119,950,903	119,347,057
Net balance‡	24,543,267	26,490,316
United Gas Improvement & subs. (Year ended June 30)		
Gross earnings	109,192,389	108,465,147
Net balance	26,135,966	28,351,604

*Deficit. †Includes non-operating revenue. ‡Available for all dividends. ¶Changed to give effect to major adjustments.

Gross earnings—(Operating Companies) Gross operating revenue. (Holding Companies) Gross operating revenue plus other income. Net balance—Balance available from income for common stock dividends.

Entire Boulder Dam Output Sought by Bohn Aluminum

Charles B. Bohn of Detroit, president of the Bohn Aluminum & Brass Corporation, has announced that his company has made an offer to the government to buy the entire output of the Bonneville Dam project. Mr. Bohn, who said the first of the ten units which his company proposes to erect at Bonneville would cost $10,000,000, declared the United States "has our offer in black and white. It can take it or leave it. But we are getting tired of the delay."

Army engineers have conferred several times with representatives of Bohn Aluminum, but the conferences "have not even reached the stage where they could be called negotiations," officials said. A bill introduced by Senator McNary would place authority to sell and distribute the power produced at the dam under the army engineers and the Federal Power Commission.

•

Copper Consumption Totals a Million Pounds Weekly

A million pounds of copper and copper alloys is being consumed each week by the mechanical refrigeration and air-conditioning industries, Bertram B. Caddle, secretary of the Copper and Brass Research Association of New York, announced last week. "According to present consumption and taking any seasonal slump into consideration," Mr. Caddle said, "the total tonnage for the year should exceed 50,000,000 lb. There has been a marked increase in sales by refrigeration and air-conditioning industries," Mr. Caddle continued, "since the extension of the amount insurable by Federal Housing Administration, under its modernization credit plan, to $50,000, which covers three large consuming markets for copper—commercial, residential and industrial properties."

•

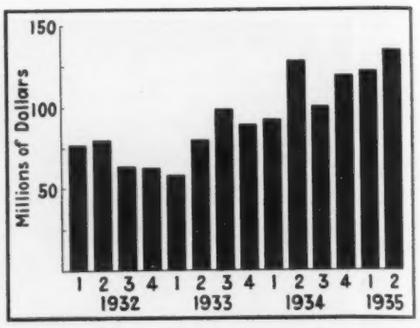
Higher Standard of Living in Sight, Swope Asserts

Addressing employees and distributors attending the annual four-day convention of the General Electric merchandising forces which opened August 12 at Bridgeport, Conn., Gerard Swope declared that the consumption of electricity in this country already had passed its 1929 peak and predicted a return to the standard of living prevailing before the depression, and probably even to a higher standard.

"Improvement in business is being manifested in many industries," he said.

"The use of electricity, in the home particularly, is increasing very rapidly; now, indeed, surpassing 1929 and making new high records, and this increase comes about from the increased use of electrical appliances, so there is ample opportunity for expansion of our business, giving steady employment at good earnings to the thousands of people here assembled. And this improvement in business is making itself manifest in other lines, so that believing in the great natural wealth of this country, the reserve power and resiliency and ingenuity of its people, we think this improvement in business and a return to our former, and even higher, standard of living is before us."

Electrical Orders 87 per Cent Over 1933



Orders for Electrical Goods by Quarters
Reported by 78 companies

Orders for electrical goods in the second quarter of 1935 rose to the largest dollar value for any similar period in three years, according to an announcement by the Bureau of the Census. The total reported by 78 manufacturing companies was $134,586,216, against $121,814,226 in the first quarter, an increase of 10.5 per cent. There was an improvement of 5 per cent over the second quarter of 1934, and a much greater gain over corresponding periods in the two preceding years: 70 per cent over 1932 and 68 per cent over 1933. The total for the half year was 64 per cent above 1932, 87 per cent above 1933 and 17 per cent above 1934.

•

League Council to Be Reorganized

A meeting to consider the reorganization of the League Council and ways and means by which the National Electrical Manufacturers Association might cooperate with the leagues throughout the country was held at the headquarters of the Electrical League of Cleveland on July 25.

A plan and scope committee was appointed to undertake the details. J. E. North was named chairman. The remainder of the meeting was devoted to a discussion of league problems of general interest, and it was definitely indicated that during the past three or four years these local bodies have made tremendous advances in their practical approach to the problems of market development in their respective localities.

NEW ELECTRIC RANGE FOR THE WHITE HOUSE

Acme

This stainless steel chromium cooking unit, 24 ft. long, will be installed next week in the Executive Mansion at a cost of approximately $5,000. The illustration shows George A. Hughes, president of the Edison General Electric Appliance Company, Chicago, manufacturer of the model, watching the test on the range and other equipment

New York Metal Prices

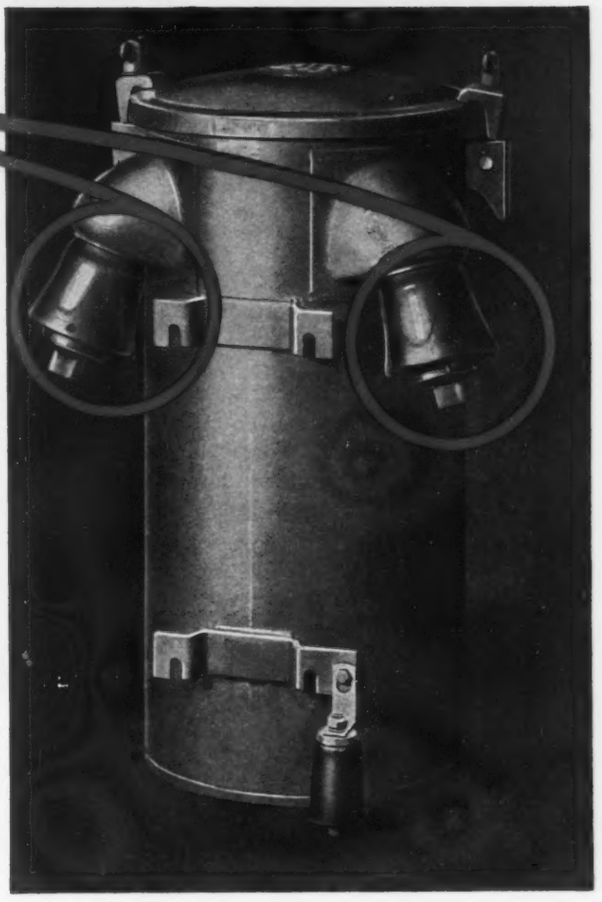
	July 31, 1935 Cents per Pound	Aug. 14, 1935 Cents per Pound
Copper, electrolytic	8.00*	8.00*
Lead, Am. S. & R. Price	4.15	4.20
Antimony	12.50	12.50
Nickel ingot	35.00	35.00
Zinc, spot	4.775	4.875
Tin Straits	52.70	49.625
Aluminum, 99 per cent	19—21	19—21

*Delivered Connecticut Valley

This New G-E Distribution Transformer Provides

Self-Contained Lightning Protection

By True Valve-Type Lightning Arresters



THROUGH its self-contained arresters, this transformer reduces the cost of installing a distribution unit that meets every requirement of modern lightning protection. The arresters, of the true valve type, utilizing Thyrite, will protect the windings and prevent needless fuse blowing, reducing outages and helping you to provide the highest standard of service.

The arrester is ingeniously combined with a removable, pocket-type, high-voltage bushing, and is an installed part of the transformer, being sealed in that portion of each bushing which is external to the tank. This arrangement places the arresters between the primary fuse cutout and the transformer, and clears up the pole installation.

Clamp-type Line Terminals
The bushing-arrester has a clamp-type line terminal which simplifies installation by providing a positive solderless connection of the line conductor to the transformer.

The bushing-arresters are held securely in the tank pocket against resilient cork gaskets, with mechanical clamps of the same type that has proved so satisfactory for many years on G-E high-voltage bushings.

Added Features

- ELECTRICALLY NEW INTERIORS
- NEW MECHANICAL STRUCTURES
- NEW CLAMP-TERMINAL BUSHINGS
- NEW TANK FINISHES

The new transformer is available in sizes 100 kv-a. and smaller, for 2400/4160 Gr. Y- and 4800/8320 Gr. Y-volt circuits. Ask for descriptive bulletin GEA-2077. General Electric, Dept. 6H-201. Schenectady, N. Y.

300-18

GENERAL ELECTRIC

OPERATING PRACTICES

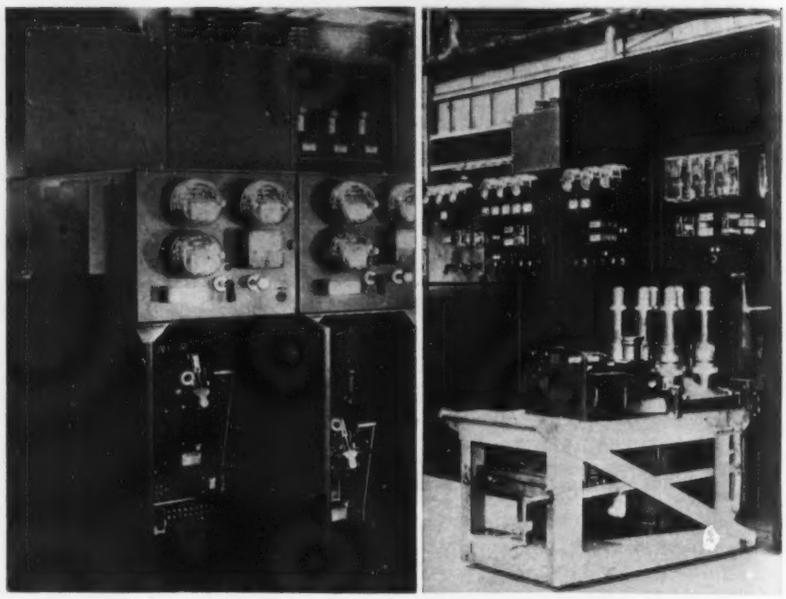
ENGINEERING • CONSTRUCTION • OPERATION • MAINTENANCE

An Indoor-Outdoor Substation

Requiring an automatic high-tension, step-down substation in a rather closely built-up residential neighborhood that objected to the conventional outdoor substation, the Scranton Electric Company employed the indoor-outdoor construction shown. Externally the substation appears as though it completely incloses all equipment and conforms architecturally with its surroundings. In many respects, however, it is an outdoor station surrounded by a brick wall and having a partial roof. There is no floor; just a cinder fill. The wall behind the transformers also serves the automatic switchboard and low-tension feeder room.

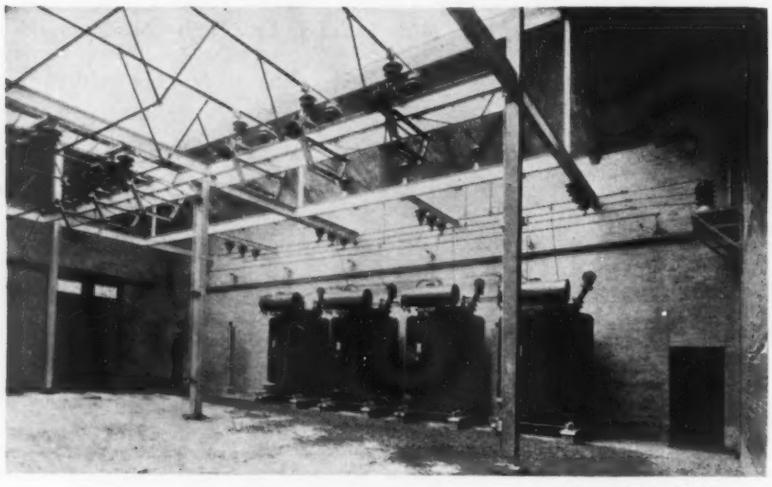
The partial roof reduces the exposure of the outdoor equipment to weather and minimizes clearances that might otherwise be necessary. It also assures good ventilation. The composition of the floor reduces transmission of any transformer vibration that may occur and simplifies the problem of handling transformer oil leakage as well as conduit connections to existing or future equipment.

Having no basement, expensive foundation, floor or roof girders, and with the brick walls substituting for some of the steel which would be required outdoors for the high-tension bus and switch supports, the station was built at considerable saving over a totally indoor substation. The station, served by underground high-tension cables, is equipped with two 4,500-kva., 22/4-kv. banks of transformers with a spare unit serving both banks.



Some of the 7,250- and, 4,150-volt switchgear

Left—The 7,250-volt units are rated at 250,000 and 350,000 kva. interrupting capacity; two 3,000-amp. units operating in parallel control the incoming circuit from the 50,000-kva. transformer bank. Right—This 4,150-volt breaker, on lifting truck, is raised when it is in cell to connect it.



American Gas & Electric Company

Inclosed outdoor substation without roof or floor

Steel-Clad Units for Fort Peck

At the Fort Peck (Montana) substation 25 metal-clad switchgear units will control the incoming lines, condenser starting and running and feeder circuits for the dredging project now under way. Each unit comprises potential and current transformers, relaying and metering equipment in addition to the removable breaker. The equipment was completely wired at the Westinghouse factory to minimize the time required for installation. Connections to outgoing circuits are made at the top or bottom of the cubicles.

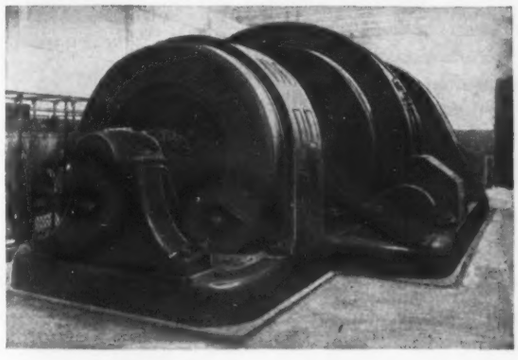
•

Crystal Oscillator for Close Control

Highly accurate control of standard frequency is secured by the use of the quartz crystal oscillator, according to a talk by Ferdinand Zogbaum of the New York Edison Company at a re-

Take your choice

G-E 2-in-1 Fuse Cutouts indicate by the door pushing out at the bottom or opening to a horizontal position . . . whichever you prefer



IT TAKES BIG THINGS TO MAKE LITTLE THINGS RIGHT

This huge motor-generator set in the high-current testing laboratory at the G-E Pittsfield Works provides the exacting conditions of large generator capacity and low power-factor—conditions necessary to the determination of fundamental design data for distribution fuse cutouts. It permits the controlled testing of these devices at full rated voltage, over the complete range from very small fault currents up to currents necessary for destruction.

Such exclusive facilities as this for research and design are your assurance that G-E cutouts will give, in service, the highest degree of protection.

IT is easy to spot a blown fuse with the G-E 2-in-1 fuse cutout. It gives positive indication—visible from the ground yet with all live parts protected. If you prefer the "drop-out" action, all you have to do is remove a small wire yoke (no tools are required), and the door drops to a horizontal position when the fuse blows.

Safety, ease of fuse renewal, positive operation, and a strong, adjustable, mounting hanger are features of this cutout. It will save you time in detecting blown fuses and restoring service.

Ask your G-E representative for information on the complete line of G-E fuse cutouts, or, if you prefer, address General Electric, Dept. 6D-201, Schenectady, N. Y., for publications giving descriptive and operating data.

340-16

GENERAL ELECTRIC

cent meeting of the New England System Operators Club. In New York the telephone company furnishes 60 cycles standard to Hell Gate station. This is received at 4 volts and is amplified to 120 volts for station use. To match the system and telephone company frequency synchronizing indicators were designed so that one indicates the standard and the other the cumulative error plus or minus. The allowable variation is 1/20 cycle plus or minus.

An important question is how closely to control frequency variations. Even with a straight-line frequency curve, load variations can be observed on the lines. Experiment shows that the tighter the frequency control the less pronounced are the load swings. If standards are set up at several widely separated points on a large interconnected system it is believed that, while retaining frequency variation within a very narrow range, load swings will also be held at a minimum.

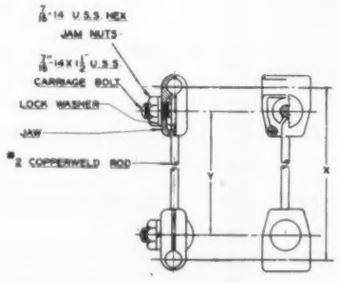
The New England Power Association is at present conducting experiments on automatic tie-line controllers. This work is being carried on at the Harriman station, and its purpose is to see if tie-line loading can be controlled without the apparatus doing the wrong thing. By means of certain blocking devices it is hoped to design the equipment so that if it is heading in the wrong direction no adverse action will be taken.

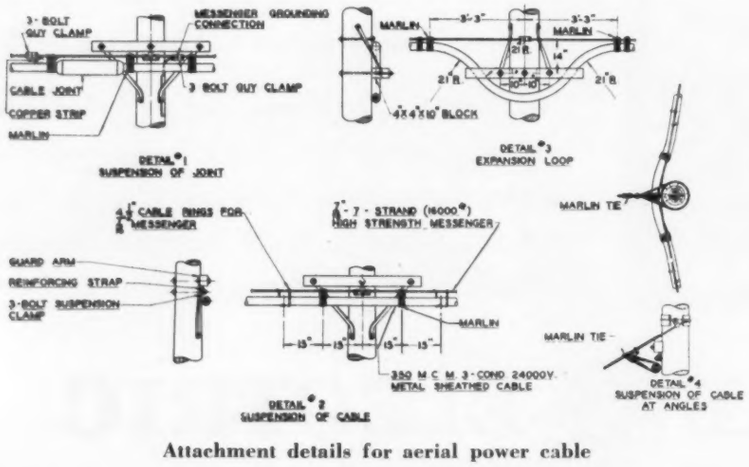
While the apparatus is very much in the experimental state, it is hoped that the device, if successfully developed, will ease off the burdens imposed on other companies so that local load swings and surges will be confined to a company's own territory.

Aerial Power Cable Installation

Aerial cables are used in special cases where conduit is not available and buried cable not desirable. The Detroit Edison Company has two installations at 24,000 volts, with 350,000-circ-mil, three-round conductors per cable, shielded, having an over-all diameter of 3.2 in. and weighing 12.8 lb. per foot. The cable is carried on a double catenary construction, the lower messenger supporting the cable by rings and being supported from the upper messenger by hangers. Messengers are 7/16-in., seven-strand, high-strength (16,000 lb.). The suspension point of the lower messenger is generally 25 ft. above ground, providing 22 ft. clearance in center of span.

"Pick-ups" or partial dead ends are installed generally on every fifth pole to keep the messenger from slipping through to any section when the cable is pulled in. Messengers are grounded every 800 ft. The hanger consists of a solid copperweld rod with jaw attached to each end, by which it grips the wire. The rods are $1\frac{1}{4}$ in. longer than the specified hanger length before the eyes are bent at the ends by jigs. The distance from center to center of eyes after being bent is $1\frac{3}{4}$ in. less than the specified hanger length. The accompanying illustrations show the hanger detail as well as attachment methods.





Attachment details for aerial power cable

Common Arrester and Neutral Grounds

By A. G. PERGANDE
Milwaukee Electric Railway & Light Company, Milwaukee, Wis.*

On the Milwaukee Electric Railway & Light Company rural distribution system in the southeastern part of the State of Wisconsin approximately 300 locations at which lightning disturbances frequently cause service interruptions were selected to test out the theory of interconnection. On about one-third of these transformers the lightning arrester ground wire was solidly connected to the secondary neutral. On another third, a 15-kv. gap was inserted in this connection, and on the remaining third the standard connection was left.

These test locations were so distributed as to place the three types of connections under investigation as closely together as possible, so that the same surge would be impressed upon the three different types of connections. Then by keeping a careful check on service interruptions and the damage to property both on the supply lines and on customers' premises and by checking the number of surges impressed on these units it was possible to obtain operating data from which to judge the value of the interconnection scheme.

During the first ten months of 1934 the surges recorded on and the performance of the various connections were as follows:

	—Type of Connection—		
	Standard	Gap Interconnected	Solid Interconnected
Number of installations...	97	98	97
Number of surges.....	265	248	273
Surges per transformer...	2.73	2.53	2.81
Service interruptions.....	19	9	10
Interruptions per 100 transformers.....	19.8	9.2	10.2

Results indicate that outages due to lightning have been reduced approximately 50 per cent through the use of the interconnection, either solidly connected or through the gap.

*From report of overhead systems committee, Wisconsin Utilities Association on "Results of Interconnecting Transformers and Lightning Arrester Grounds."

These BRAZED and SWAGED Joints Give G-E Power Transformers GREATER RELIABILITY and LONGER LIFE

TO ASSURE the highest degree of reliability, internal conductor and cable connections in G-E power transformers are made by brazing or swaging.

PERMANENT CONNECTIONS are electrically brazed. The joints are made by the simultaneous application of high current, mechanical pressure, and brazing alloy, as illustrated above. The alloy combines with the conductor and forms a new alloy having a melting point more than three times that of the solder ordinarily used for this purpose.

DETACHABLE CONNECTIONS are usually made by swaging terminals to cables, as shown below, and by brazing terminals to other conductors. Swaged terminals provide the most dependable, electrical, and mechanical connections thus far developed for use with flexible stranded cable.

THESE JOINTS are just two of many reasons why G-E power transformers stand up in service. Every detail of material and workmanship contributes to one objective—the most reliable transformer that can be made.

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

310-5

GENERAL ELECTRIC

Twice Fatigue Value by Hydrogen Welding

By L. F. HOSLEY
Indian Motocycle Company, Springfield
and W. B. PARKER
General Electric Company, Boston

Increased speed of production and reduced finishing resulted from a recent installation of atomic hydrogen welding in fabricating mufflers and luggage carriers at the factory of the Indian Motocycle Company, Springfield, Mass. Shortly after the use of this application began, and with the desire to improve the company's product, it was suggested that electric welding be tried on the front fork assembly as a substitute for prevailing brazing. It was found that the weld would withstand a considerably greater shearing pressure and that the ability of the assembly to survive mechanical tests of fatigue was more than doubled. Four General Electric atomic hydrogen welding outfits are now in service at this plant, with an ammonia dissociator of the same manufacture.

The four units used at Springfield consume an average of 3 to 4 kw. each and operate on a duty cycle of about 50 per cent. In a motorcycle side-car frame about 50 parts previously brazed are now electrically welded, and as a result the filing process formerly required has virtually been eliminated.

The cost of hydrogen delivered to the electrode holder has been practically halved by the installation of a dissociator which supplies hydrogen by electrically heating anhydrous ammonia with an energy consumption of about 10 kw. The heating units are of the 220-volt ribbon type and maintain an internal temperature of about 1,600 deg. in the dissociator coil, with an automatic regulation of about 50 deg. plus and minus.

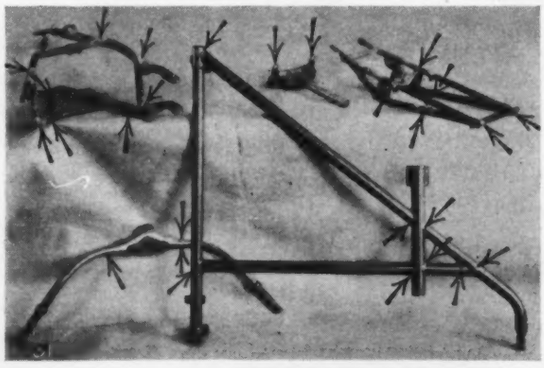
•

Modernization Cuts Power Costs

Reductions of compressor horsepower brought about through the use of modern and efficient ice-making equipment nearly always result in appreciable reductions in unit power costs.

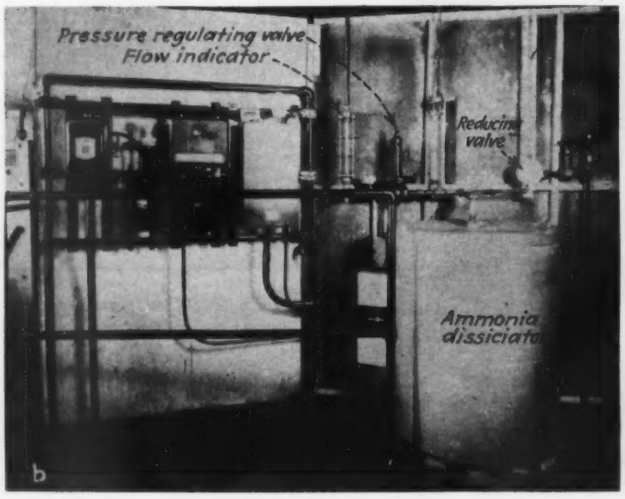
One feature of a modernization program advocated by H. D. Graham of the York Ice Machine Company at a recent convention of the Louisiana-Mississippi Ice Association involves the use of vertical trunk ammonia coils between brine coolers. This type coil, operating at a higher back pressure than older types of coils, decreases the necessary compressor horsepower, per ton of ice, from 2 to 2.5 per cent for every pound increase in compressor suction pressure. Hand adjustment of expansion valves is obviated by a simple float valve in this type ammonia coil.

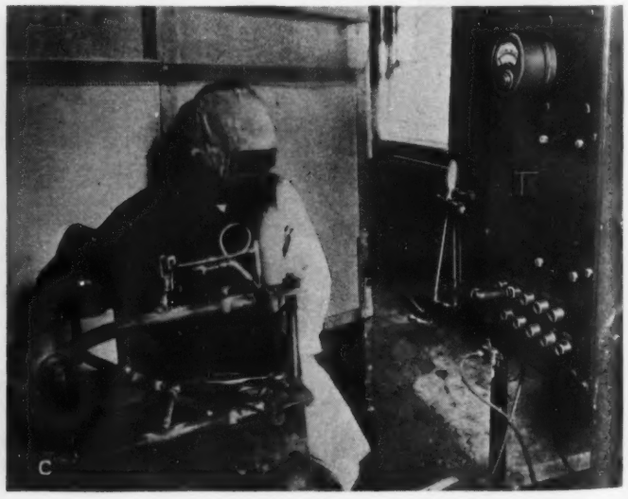
Mr. Graham also pointed out that in single-compressor ice plants having electric drive two-speed motors may often be profitably used to reduce metered demand and increase suction pressure during winter months. Another method of accomplishing the same results by the use of partial by-

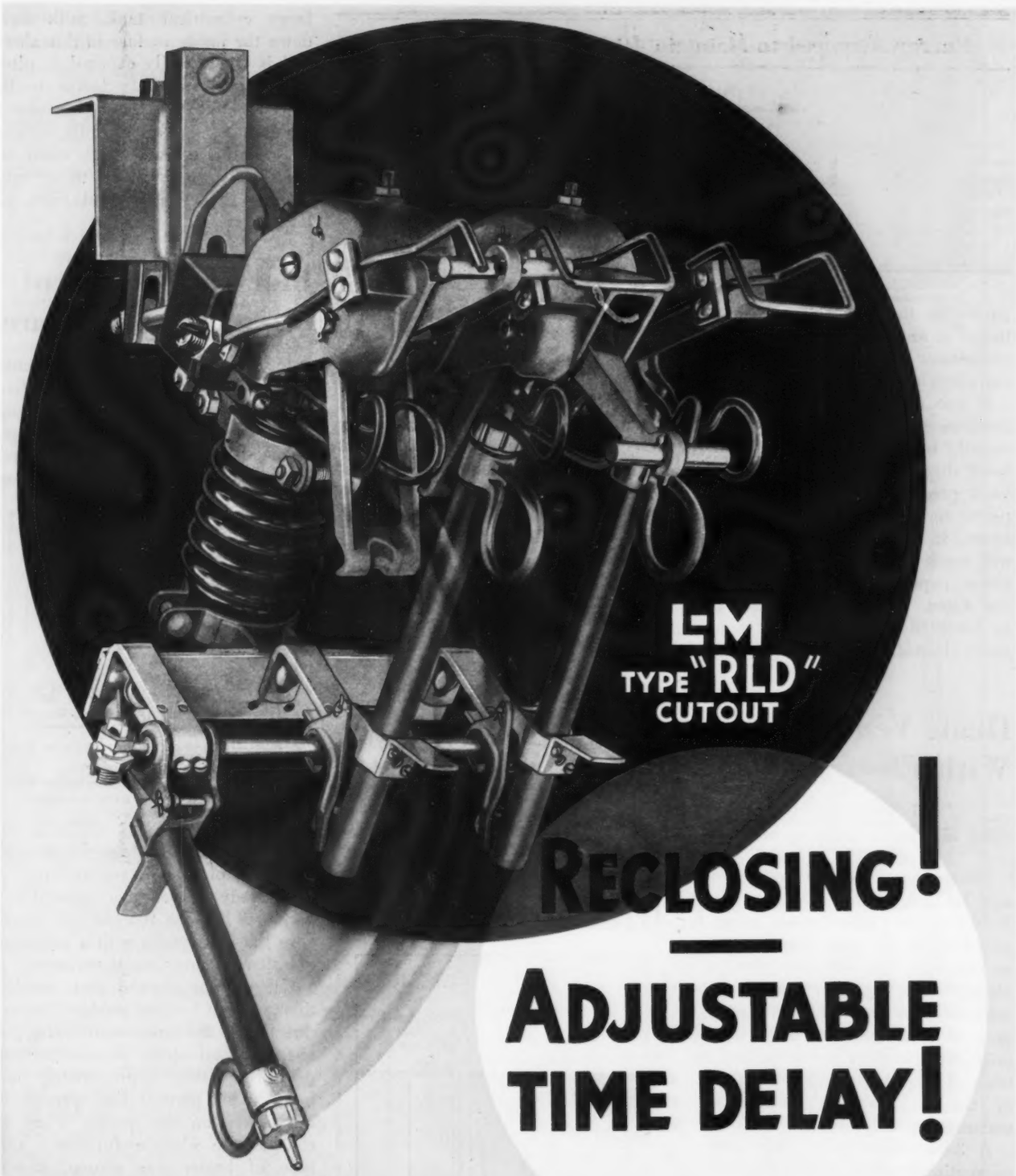


Tubular parts fabricated by atomic welding

(a) Motorcycle and side-car framing now electrically welded by atomic hydrogen process. Between 40 and 50 electric welds are required in these sections, formerly brazed throughout. (b) Hydrogen dissociator with control equipment at left. Temperature control automatic within about 3 per cent of established level. (c) Operator welding motorcycle frame. Push-button control enables the operator to re-establish the arc by closing the supply circuit which opens automatically when the arc is broken.







RECLOSING!

ADJUSTABLE TIME DELAY!

RECLOSES the circuit automatically after a predetermined interval, best suited to the line requirements.

The built-in time delay device can easily be adjusted, it will cut in the following fuse instantaneously or after any interval up to two seconds. It is foolproof.

All cartridges are in the up or closed position when links are intact. After blowing, the cartridge drops down, can be located and replaced immediately.

Type RLD is available in 100 amps. capacity, in two- and three-gang construction, in ratings up to 15,000 volts.

LINE MATERIAL CO

SOUTH MILWAUKEE, WISCONSIN, U. S. A.

Energy Required to Maintain 40 Deg. Within Building

	1932–1933				1933–1934			
	Temperatures				Temperatures			
	Mean	Max.	Min.	Kw.-Hr.	Mean	Max.	Min.	Kw.-Hr.
December	32.5	64	—10	110	24.2	47	—19	240
January	33.4	55	+ 6	242	25.8	52	— 5	412
February	30.2	63	+ 1	270	14.9	43	—22	536
March	32.2	55	+ 5	202	32.0	61	— 1	384
April	43.6	79	+24	78	46.8	74	+25	72
Season				902				1,644

passes on the compressor was mentioned as an efficient way of reducing compressor capacity and power without changing speed.

It was also pointed out that dirty condensers can be a source of unnecessarily high power costs. Accumulated dirt tends to build up excess head pressure, thus requiring more power to drive the compressor. Increases in head pressure of 10 per cent will result in a 5 per cent increase in power required at the compressor, it was stated. This is a strong argument in favor of condensers that can be easily cleaned.

•

Heats Venturi House With Electricity

By H. A. HANDS
New England
Power Engineering & Service Corporation,
Boston, Mass.

Electric heat was installed two years ago by the Clinton (Mass.) Water Works in its Venturi meter house to guard against freezing during the winter months. An oil stove had previously been used for this purpose, requiring the time and expense of a man to make the trip daily to this point, situated three or four miles from town. This expense, together with that of the oil, annual painting, etc., amounted to at least $140 annually.

A 3-kw. convection heater and a conventional type room thermostat were installed at a cost of about $50. The power cost for the first season was less than $40 and for the second season below $70. It therefore appears that in two years not only has the equipment been paid for, but a sum approximating $120 has been saved the town on this one minor project. In addition, the hazard of damage caused by a sudden unseasonable cold snap has been entirely eliminated, as has all danger due to negligence on the part of the human attendant.

The Venturi meter house is small and well constructed. The walls are of brick and 13 in. thick. The outside dimensions are 113x90x86 in. to the eaves. The roof is of slate on sheetrock on timbers and slants in all four directions. There is a pine door on the east side and double windows on the north and south sides. Inside there is a matchboard ceiling 96 in. above the concrete floor.

The average temperature from October to April, inclusive, was assumed to be 30 deg. Equipment sufficient for a 25-deg.-below outside temperature was installed, although such a low temperature is not usual. The logic of it was demonstrated this last winter, however.

Similar applications of electric heat to isolated or hazardous locations are numerous and are being converted daily.

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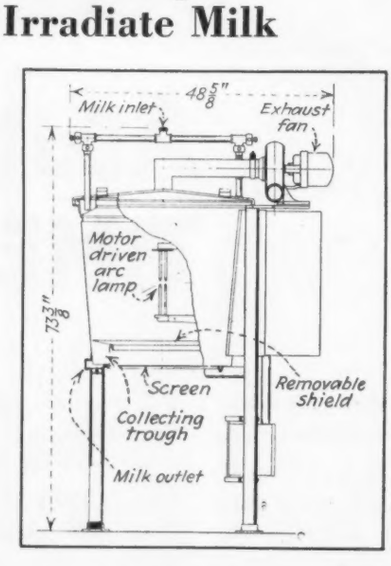
Arc Lamps Irradiate Milk



Ultra-violet light from a number of carbon arc lamps is being used by the Otto Suburban Dairy Company, Emsworth, Pa., to irradiate milk. Introduced just inside the top rim of a large cylindrical tank, milk flows down the inside surface in thin sheets and is momentarily exposed to ultra-violet light from arc lamps in the center of the tank. This process is reported to provide the milk with an extra supply of vitamin D, which enables the body effectively to use minerals of which bone and teeth are formed.

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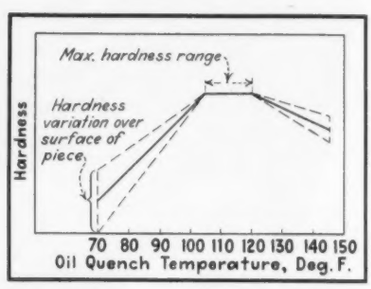
Electric Control of Quench Temperatures

In an effort to produce better, longer-lived tools and dies the Geometric Stamping Company, Cleveland, found that careful temperature regulation of the quenching medium used in heat treating tools greatly improved


Max. hardness range
Hardness variation over surface of piece
Hardness
70 80 90 100 110 120 130 140 150
Oil Quench Temperature, Deg. F.

Quenching curve shows range for maximum hardness
For temperatures above and below this range hardness varies over the surface of the piece

the uniformity of hardened pieces, R. Haserodt, plant manager, reports. A little study proved that quench temperatures between 105 and 120 deg. F. gave the best results with a minimum of soft spots over metal surfaces.

Calculations showed that installation of 12 kw. of midget heaters directly in the tank would bring the quenching oil up to the desired temperature within approximately one hour. This permits the operator to cut power on the quench when he charges the electric furnace. This type of heater was chosen, it was stated, since it provided better efficiency, greater safety and uniform heating. Power supplied to the heaters is controlled by a thermostat with a differential of plus or minus three degrees.

Though no test data are available, it is reported that a better product has been obtained since this installation was made. This and other automatic electrical equipment has eliminated all guesswork in heat-treating metals, it was stated.

Advanced Lighting in Auto Showroom

[*Continued from page 55*]

about 1 cent per kilowatt-hour and the cost of lighting is $2 per hour for very high intensity of balanced color lighting for a showroom nearly a city block long.

Ceiling, walls and floor are all light color, which reflects the most light and gives the greatest contrast to the cars displayed.

Albert Kahn was the architect on this building and Martin Gibson Company furnished and installed the lighting fixtures.

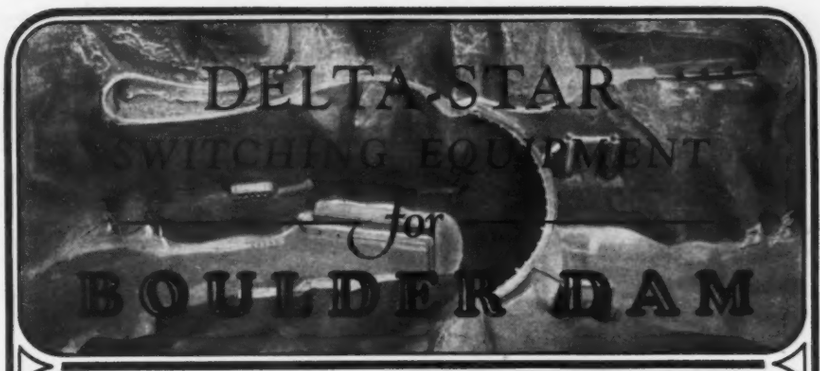
Chris G. Sinsabaugh, editor of *Automotive Daily News*, estimates that there are 60,000 automobile showrooms in this country and that nearly all of them are poorly lighted, which is a detriment to displaying and selling cars.

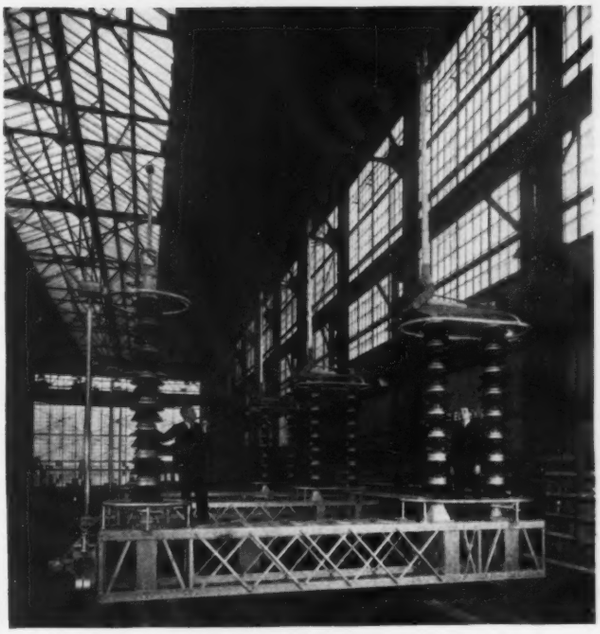
J. E. Fields, president of the Chrysler Sales Corporation, states: "We think this is a wonderful lighting system." E. B. Foss, manager of the showroom, remarked: "It is just the same as showing the cars in good daylight. You can see the design, color and details of the inside of the cars as well as the outside." C. L. Jacobson, manager of district branches, states: "Four times as many passers-by stopped at the windows lighted by combination units as were attracted by other lighting."

•

New 25-Mile Line to Be Built in Northwest

A new interconnection in the Northwest tying in the Ariel plant of Inland Power & Light Company on the Lewis River, state of Washington, and the system of the Washington Gas & Electric Company at Longview in that state, is to be built immediately pursuant to a contract just concluded between these two companies. The line, 25 miles long, will be H-frame wood-pole construction, insulated for 66,000 volts with clearances for 110,000, and will have 25,000 kw. capacity. Sixteen miles of it from the plant to a point near Kalama, Wash., will be built by the regular construction crew of Pacific Power & Light Company, owner of Inland Power & Light, and the other nine miles with substation equipment will be constructed by Washington Gas & Electric Company. The tie-in will make a larger and more economic use of hydro-electric capacity at Ariel. It will also furnish an additional source of supply to the northern end of Northwestern Electric Company's system in the state of Washington, now supplied in part by a power contract with Puget Sound Power & Light Company, Seattle, for power supplied at Kalama.





In the Silver Lake and Victorville switching stations on the 275 kv. line to Los Angeles are sixteen 287 kv. 1,200 ampere type "MR-239" 3-pole motor operated disconnecting switches.

This vertical lift metal-clad switchgear will control two 3,000-kva. station service bank and all 2,300-volt feeders supplying the power-house auxiliary equipment at Boulder Dam. The assembly consists of 30 units, 15 in a row, back to back, with a cable-way between.

DELTA-STAR ELECTRIC CO.
2400 Block, Fulton Street • • • Chicago, Illinois

NEW ENGINEERING IDEAS

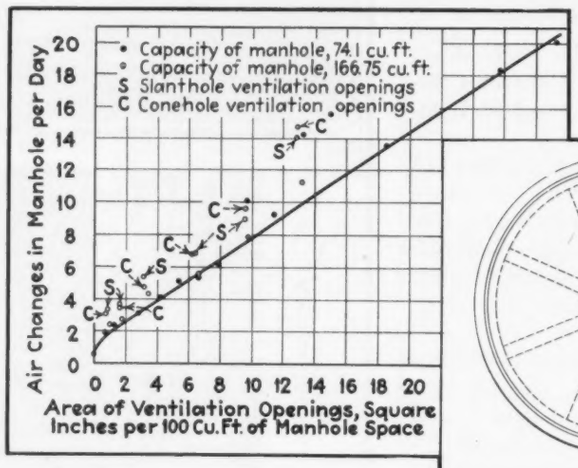
THEORY • DESIGN • MANUFACTURE • CONSTRUCTION • UTILIZATION

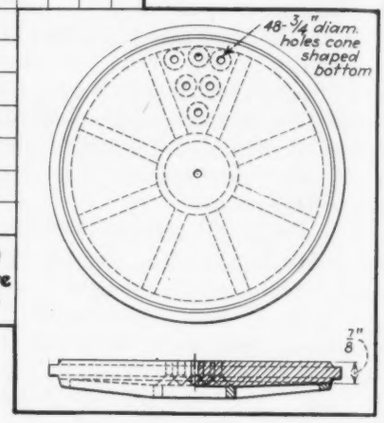
Night Tests Show Driving Visibility

A number of visibility tests to determine the distance at which the driver of an automobile can see pedestrians walking along the side of the highway at night have been conducted as part of the Massachusetts Highway Accident Survey, Civil Works Administration Project No. 3493, under supervision of the Massachusetts Institute of Technology.

Results of these tests were reported in the March *Journal* of the Franklin Institute by Parry Moon and R. C. Warring. Maximum safe speeds at night on unlighted highways were found to be 30 m.p.h. when there is glare from passing cars and 40 m.p.h. when glare is absent.

These tests were performed on a number of pavement surfaces, both lighted and unlighted. Tests were made at speeds of 10, 20 and 40 m.p.h. with the pedestrian in (a) dark clothing, (b) with small area of white, (c) with large area of white. In some cases reflector buttons were used. All runs were repeated with an opposing car stationed on the left side of the road and its headlights as follows: (1) Depressed legal beam; (2) normal legal beam; (3) raised illegal beam. The pedestrian in all cases was slightly behind the opposing car.


Capacity of manhole, 74.1 cu.ft.
Capacity of manhole, 166.75 cu.ft.
S Slanthole ventilation openings
C Conehole ventilation openings
Air Changes in Manhole per Day
Area of Ventilation Openings, Square Inches per 100 Cu.Ft. of Manhole Space



Experimental manhole cover with cone-shaped ventilation openings

•

Cover Ventilation Safeguards Manholes

Extensive tests recently completed by the U. S. Bureau of Mines on manhole ventilation show that the number of air changes per day in the manholes studied were in general proportional to the area of ventilation openings per 100 cu.ft. of manhole space. A report on these tests has been prepared by W. P. Yant, G. W. Jones and W. E. Miller of the bureau and John Campbell, superintendent, special service department, Boston Edison Company, which, with the Boston Consolidated Gas Company, has been co-operating with the government to prevent explosions in underground structures.

In an experimental manhole with a capacity of 74.1 cu.ft. and a cover 27.5 in. in diameter, the tests showed that the number of air changes per day was almost directly proportional

Results of Driving Visibility Tests

General Summary of Visibility Distances (Ft.), Unlighted and Lighted Pavements

Pedestrian wearing	(a) Dark Clothes	(b) Small Area White	(c) Large Area White	Average of a,b,c,
1. With Test Car Only				
Unlighted rough macadam	197	300	387	295
Unlighted smooth macadam	195	291	377	288
Unlighted concrete	201	320	393	304
Lighted rough macadam (a)*	200	296	327	274
Lighted concrete (b)	253	288	340	294
Lighted concrete (c)	134	196	241	190
2. Opposing Car With Legal Normal Beam				
Unlighted rough macadam	166	272	334	257
Unlighted smooth macadam	139	230	281	217
Unlighted concrete	172	284	348	268
Lighted rough macadam (a)	159	241	279	226
Lighted concrete (b)	296	318	301	305
Lighted concrete (c)	127	194	225	182
3. Opposing Car With Legal Depressed Beam				
Unlighted rough macadam	184	292	356	277
Unlighted smooth macadam	178	285	347	270
Unlighted concrete	192	315	368	292
Lighted rough macadam (a)	173	288	318	260
Lighted concrete macadam (b)	271	333	342	316
Lighted concrete macadam (c)	134	210	253	199
4. Opposing Car With Illegal (Raised) Beam				
Unlighted rough macadam	125	225	270	206
Unlighted smooth macadam	95	164	206	155
Unlighted concrete	147	252	301	233
Lighted rough macadam (a)	121	197	224	181
Lighted concrete macadam (b)	271	291	289	284
Lighted concrete (c)	98	174	198	157

*Key to lamp spacing and rating:

(a) Three locations averaged	Spacing 265 ft.	Rating 800 lumens
	Spacing 500 ft.	Rating 800 lumens
	Spacing 250 ft.	Rating 600 lumens
(b) One location only	Spacing 150 ft.	Rating 6,000 lumens
(c) Two locations averaged	Spacing 700 ft.	Rating 800 lumens
	Spacing 525 ft.	Rating 800 lumens

HI-PRESSURE CONTACT DISCONNECTING SWITCHES
34,500 VOLT . . . . . 2,000 AMP. TYPE RSR

● Switches installed at Terminal Station C.—in groups of two line switches and one grounding switch, interlocked mechanically and electrically to prevent improper operation. Line switches motor operated—grounding switches manual. Shop view shows one unit.

RAILWAY and INDUSTRIAL ENGINEERING CO.
GREENSBURG, PA.

R&IE
HI-PRESSURE CONTACT SWITCHES

to the number of openings in the cover. The provision of 48 holes rated at 0.75 in. diameter reduced the gas concentration to less than 1/30 of that present with no holes. More extensive tests were made on a second manhole of Boston Edison type, having a capacity of 166.75 cu.ft. The results were comparable with the data from the smaller manhole, but the percentage of ventilation rose from 39 to 121 per cent for accelerated wind velocities. The average increase in air changes per day per square inch of ventilation opening for all tests for either the slant or cone type of cover apertures is about 30 per cent greater than the regular vertical openings at wind velocities of 0.7 mile per hour or less, and for velocities varying from 7 to 10.3 miles per hour there was an average gain of 64 per cent for the diagonal holes and 45 per cent for the cone hole openings. The cone hole type has the advantage of avoiding the clogging of the openings.

•

Sags and Tensions on Comprehensive Chart

By BRENTFORD R. MACKEY
Wayne, Pa.

Establishing four ratios of the various quantities involved in sag and tension problems affords the opportunity to present on a single co-ordinate area practically all the interrelated quantities if any two of the ratios be known or assumed. These ratios are loading ratio, length ratio, sag ratio and tension ratio. The first can always be calculated from the known data. The problem conditions will give at each step one other ratio which will, with the loading ratio, locate a point on the chart area and thus indicate the remaining quantities through the medium of their ratios.

Changes in loading do not affect the length ratio and they are therefore represented by a horizontal locus on the chart. Changes in temperature do not affect the loading ratio and therefore have a vertical locus. For a temperature change the previous value of the length ratio is changed by adding algebraically the product of temperature coefficient × degrees change × length ratio. This is rendered simple because the length ratio can be called unity, inasmuch as it differs from it by less than 2 per cent for any value of sag ratio up to 10 per cent.

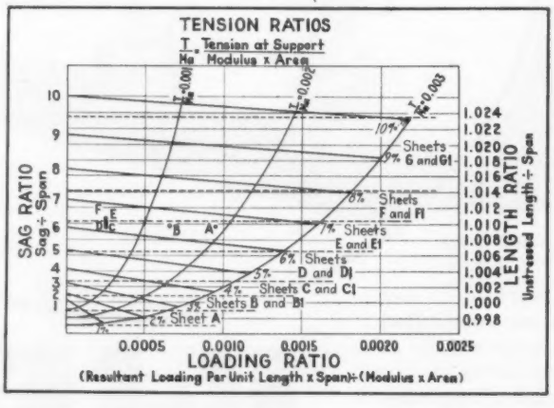
The chart shown is merely a key to indicate which detailed chart applies to a particular set of conditions. The thirteen detailed charts have been computed from the rigorous hyperbolic formulas and plotted to 7½x12-in. co-ordinate dimensions on which the sag ratios can be read to 1/10,000 of the span. Accuracy of 1 per cent in reading tension ratio is generally possible. Incidentally, the charts are universal in that, being plotted as ratios, they hold for English, metric or any other system of units.

All conditions have been converted to the four ratios defined on the chart.

EXAMPLE: A 1,000-ft. span of No. 0 stranded bare hard-drawn copper is to be strung to have maximum tension of 30,000 lb. per sq.in. when loaded with ½-in. ice and 8 lb. wind at 0 deg. F.

For the limiting condition tension ratio is 0.001875 (for 16,000,000 lb. modulus and 0.083 sq.in. area). Loading ratio is 0.000949 (for 1.26 lb. resultant of 0.323 lb. wire and 0.866 lb. ice per foot). Chart E-1 gives length ratio 1.00961 and sag ratio 0.0658 or the sag is 65.8 ft. in direction of resultant.

Sags and tensions at other temperatures and loadings can be located as indicated in the text. Thus A is for maximum loading, B for ½-in. ice and no wind, C for no ice or wind at 0 deg. F., D for 30 deg., E for 60 deg. and F for 90 deg.

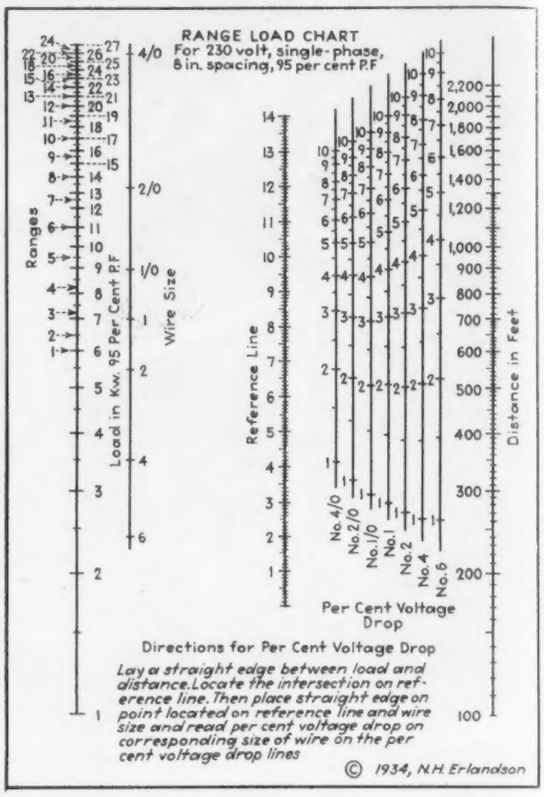


New chart for sag and tension calculations

Voltage Regulation on Range Circuits

By NELS H. ERLANDSON
Asheville, N. C.

Based on a study of range load demands is a nomogram which indicates the percentage voltage drop which ranges occasion with various sizes of wire used for the 230-volt secondaries. The chart assumes 8-in. spacing of conductors and 95 per cent power factor; it covers up to 24 ranges or 27 kw. at distances as high as 2,200 ft. for the lesser numbers of ranges. By merely reversing the procedure indicated on the accompanying chart the limiting load or distance for a predetermined drop with an existing size of wire can also be found. Thus, for 3 per cent drop on No. 4 wire the index is 6.45 on the central scale and the distance for 2 ranges is 420 ft., for 4 ranges is 334 ft., etc. Not more than 5 ranges can be served at 280 ft. if 3 per cent regulation is stipulated.


RANGE LOAD CHART
For 230 volt, single-phase, 8 in. spacing, 95 per cent P.F
Ranges
Load in Kw. 95 Per Cent P.F
Wire Size
4/0
2/0
1/0
Reference Line
No. 4/0
No. 2/0
No. 1/0
No. 1
No. 2
No. 4
No. 6
Per Cent Voltage Drop
Distance in Feet
Directions for Per Cent Voltage Drop
Lay a straight edge between load and distance. Locate the intersection on reference line. Then place straight edge on point located on reference line and wire size and read per cent voltage drop on corresponding size of wire on the per cent voltage drop lines
© 1934, N.H. Erlandson

If the charge is to be used for 115 volts the voltage drops should be multiplied by 4 or the load and distances divided by 4.

INSURE EFFICIENCY and ECONOMY

by using PP INSULATORS

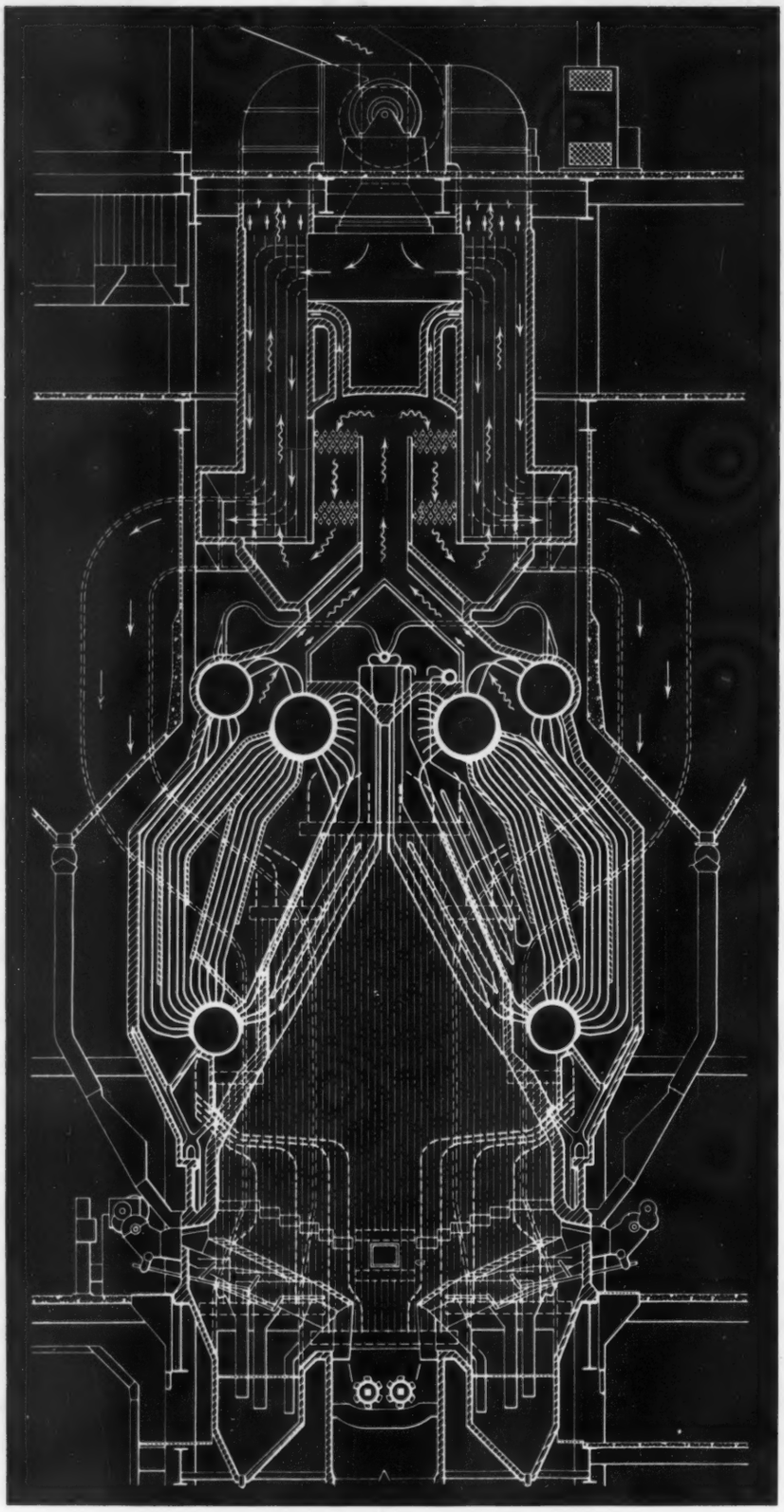
BACK OF PP INSULATORS

is the experience and reputation of an old established manufacturer. Porcelain Products, Inc., has built up an efficient engineering and production staff to cooperate with our customers in maintaining and improving the high standards demanded in up-to-date operating practice. A modern continuous tunnel kiln, equipped with electrical recording and control instruments and fired with natural gas the most satisfactory fuel available for this purpose, assures the highest in quality and *uniformity* of product. Over twenty-five years of service are behind every insulator produced.

LONG LIFE that means low maintenance costs—economy in construction to hold down the cost per service, will be the watchwords as the rural lines go up. • To assure freedom from insulator troubles at moderate costs, specify PP Insulators, on transmission or distribution jobs. PP Insulators are made to the highest standards by men thoroughly familiar with the problem at hand. Even the smallest insulator is thoroughly tested electrically. From blue-print to finished product, they are right. Compared from the standpoint of design, of mechanical strength, or by dielectric test—PP Insulators measure up. • For full information, specifications and price . . . write Porcelain Products, Inc., Parkersburg, W. Va.

PORCELAIN PRODUCTS INC. . . . PARKERSBURG, W. VA.

DETROIT EDISON Orders



● *Sectional elevation of one of six C-E Boilers (2 operating, 2 being installed and 2 on order), Connors Creek Station, Detroit Edison Company. Capacity—330,000 lb. per hr. at normal full load; Pressure—710 lb. gage; Final Temperature—850° F; Heating Surfaces: Boiler (C-E)—26,764 sq.ft.; Superheater (Elesco)—10,967 sq.ft.; Water-Cooled Walls (C-E)—3,417 sq.ft.; Economizers (Elesco)—8,620 sq.ft.; Air Heaters (C-E)—28,980 sq.ft.*

COMBUSTION

2 MORE C-E BOILERS for Connors Creek

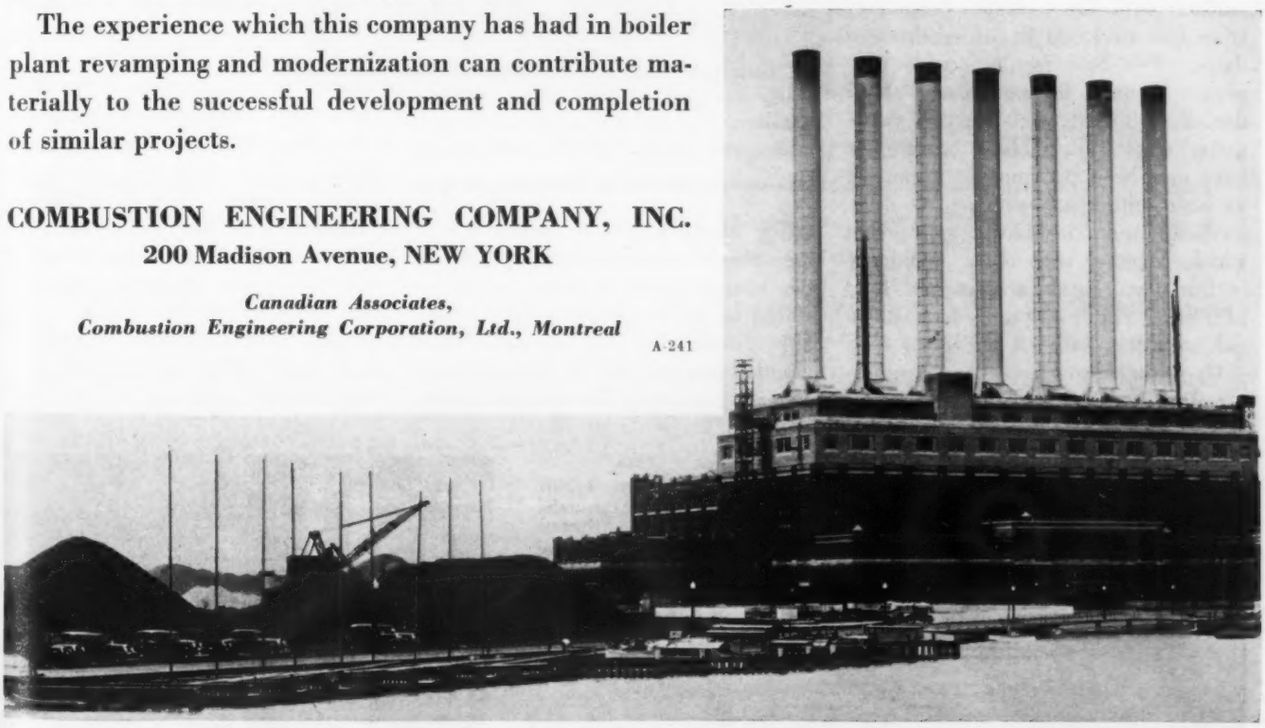
Modernization of Connors Creek passed into its third stage with the recent purchase of two more C-E Bent Tube Boilers and auxiliaries. The first two boilers, ordered in the latter part of 1932, have been in operation for some time past, and the erection of the second two, ordered in mid-summer of 1934, is nearing completion.

These six C-E boilers, details of which are given on the opposite page, will nearly triple the capacity of the units they replace and will effect a material reduction in the station heat rate.

Combustion Engineering's identification with this notable modernization project is an important addition to its record of service to the central station industry. Not only has C-E equipment been selected for a majority of the most outstanding utility installations made in recent years, but it has also been chosen for the largest and most notable boiler plant projects in the industrial field. Examples of the latter are the 1400-lb. pressure units for the Ford Motor Company and the Firestone Tire & Rubber Company.

The experience which this company has had in boiler plant revamping and modernization can contribute materially to the successful development and completion of similar projects.

Connors Creek Station, Detroit Edison Company



COMBUSTION ENGINEERING COMPANY, INC.
200 Madison Avenue, NEW YORK

Canadian Associates,
Combustion Engineering Corporation, Ltd., Montreal

A-241

ENGINEERING

BUILDING UP THE LOAD

APPLIANCES, LIGHTING AND POWER • DOMESTIC • COMMERCIAL • INDUSTRIAL

Conditioned Air Increases Mushrooms

By F. H. ALLEN
Southern California Edison Co., Ltd.
Compton, Calif.

Air conditioning the growing beds of the California Mushroom Farm at Whittier, Calif., has proved a profitable investment, because it has made possible operations during the summer months. Heretofore the cool, moist air essential to successful mushroom culture could not be obtained within the growing houses when outside temperatures were hovering around 100 deg. F., and consequently mushroom houses either had to be shut down during the summer or operated at an appreciable loss.

Twenty hollow-tile and plaster type houses are used as growing beds for the mushrooms, each containing approximately 110,000 sq.ft. of growing surface with an average output of from 800 to 1,000 lb. of mushrooms daily. For best results, inside temperatures must be maintained at 55 deg. F., with extremely narrow variations allowable. These conditions have now been provided by means of an air-conditioning system of cooling, washing and circulating equipment which, together with other machinery in the plant, totals a connected load of 97 hp. The installation uses 10,000 gal. of water daily.

Operating costs have been comparatively low, energy consumption totaling about $200 per month during the summer and $50 per month during the winter. The air-conditioning installation is, therefore, a very profitable investment, for it adds three months per year to the growing season and improves the product during the entire year. Southern California Edison Company engineers helped to solve the problem.

READY KILOWATT
(Your Electrical Servant)
To Mr. and Mrs. Philadelphia
City
Complete Electric Service for 30 Days
Sweeping, dusting, cleaning 9 cents
Providing accurate time, 3 rooms 21 cents
Dishwashing after 90 meals 11 cents
Exhausting cooking odors from kitchen 15 cents
Mixing batters and salad dressings 10 cents
Operating sewing machine 4 cents
Providing delicious coffee twice a day 20 cents
Crisp toast at every breakfast 20 cents
Radio entertainment every day 42 cents
Health-guarding ultra-violet radiation 41 cents
Ironing 30 cents
Washing 10 cents
Adequate light 140 cents
Refrigeration 150 cents
Cooking 300 cents
Dependable hot water 300 cents
PHILADELPHIA ELECTRIC COMPANY

Still another angle on the cheapness of using electricity in the home. "Ready Kilowatt" for the Philadelphia Electric makes out a typical bill for full service.

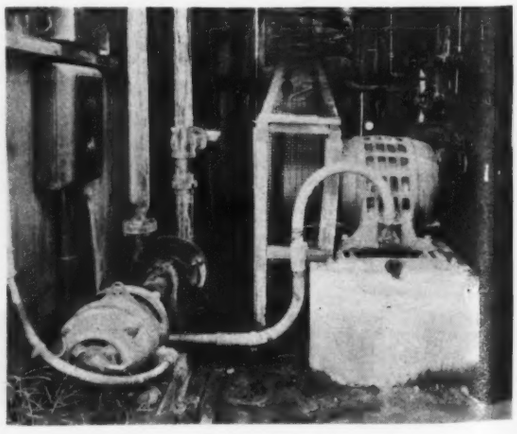
•

An Expériment in Spot Lighting

Roy A. Palmer, illuminating engineer of the Southern Public Utilities Company of Charlotte, tells of an interesting experience which revealed the value of light as a sales builder. A show window in a new building had been equipped with an unusually good lighting system. Since this new store was not occupied, a department store located two blocks away arranged a display in the window consisting of three figures dressed with the latest of women's apparel. The window's general lighting system illuminated the entire window and a spotlight was trained on the center figure.

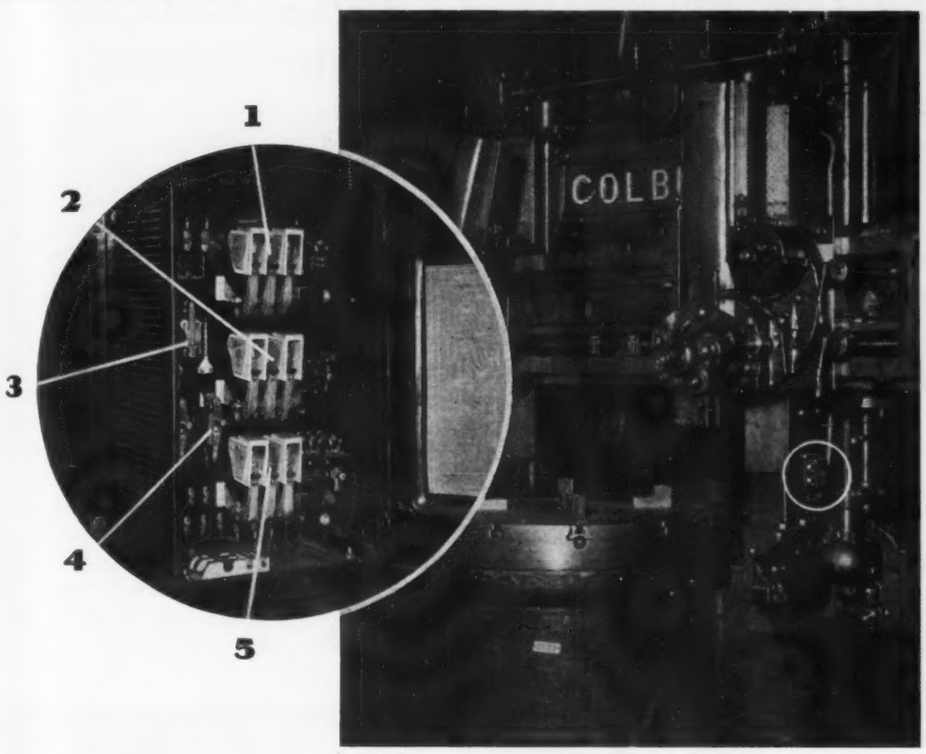
After the display had been in for a few days it was noticed that the display man was making frequent visits to the window to change hats on the figures. On inquiry it was found that the hats were being sold and that invariably it was the hat from the center spotlighted figure. The experiment of substituting a hat from one of the other models in the window showed that the window shoppers still selected hats from the center figures. Several dresses from this same figure were also sold. The spotlight not only drew more attention to the center

800 to 1,000 lb. of mushrooms gathered daily for an anxious consuming public



Part of the electric equipment that keeps the temperature down to around 55 deg.

Positive Control
Quick, Accurate Stop



1 Contactor which cuts out plugging resistor when motor is to be jogged or inched in reverse.

2 Reverse and plug brake contactor.

3 Thermal overload relay.

4 Non-interference relay... prevents accidental starting of motor when movement of machine closes brake switch.

5 Forward main line contactor.

THIS 48-inch Colburn Boring Mill in the Canton, Ohio, plant of the Timken Roller Bearing Company is Monitor-controlled. It is driven by a 15-hp. three-phase induction motor connected directly across the line when starting.

The control station is mounted on the machine and provides run forward, jog forward and reverse, automatic and accurate brake stop, with rate of deceleration determined by resistor of correct value. The controller protects the motor from damage due to single-phase running, low voltage and overload.

The contactors are electrically and mechanically interlocked and the motor is prevented from accidental starting in case the work table is moved by hand to close the brake switch.

Wherever electricity is used Monitor has the right controllers custom-built to fit the job and yet priced competitively with mass production ready-made controllers.

MONITOR CONTROLLER COMPANY
Gay, Lombard and Frederick Streets, Baltimore, Md.
BRANCH OFFICES IN PRINCIPAL CITIES

IF YOU HAVE A CONTROL PROBLEM . . . CONSULT MONITOR

Monitor

DOES IT *AUTOMATICALLY*

model, but also caused the merchandise to appear to better advantage, thus creating a demand for it over that on the other models in the window.

•

Electric Cooking for Picnickers

Ultra-modern convenience is provided for picnickers at the Crystal Lake playground of the city of Los Angeles, in the shape of hot plates set in natural stone foundations, as shown in the accompanying illustration.

Each grill is controlled by the conventional two-heat switch and the energy consumption is limited by means of a coin-operated meter. This electric kitchen in the open proved extremely popular with the citizens of Los Angeles who frequent the many natural playgrounds maintained by the city.

Plant Visit Leads to Social Center

Some months ago a branch of the Parent-Teachers Association in Loraine, Ohio, was searching for a suitable place in which to hold a benefit bridge party. The wife of the power plant superintendent suggested holding the meeting at the Edgewater power plant of the Ohio Public Service Company. The boiler room was selected as the site for the function and approximately 200 men and women attended and were served coffee and sandwiches free by the company. The interest created by the affair ultimately led to the construction of an all-electrical kitchen and entertainment quarters in the plant.

A complete electrical kitchen, with entertainment rooms sufficiently large to place 25 bridge tables, is located on the second floor. Tables for overflow crowds are placed in the control room, which is adjacent to the kitchen. The kitchen is ultra-modern, well-lighted and a show place. The rooms and kitchen are available for use by clubs and social organizations. Work was completed the first week in April and seventeen organizations had reserved dates up to May 22.

The company provides a hostess, who assists the club committee and also helps in the preparation and serving of the refreshments. She is trained in the use of the appliances on display. The guests are invited to inspect the plant and this 30,000-kw. station will hereafter be an active builder of good will.

•

College Girls Sell Better Lighting

Energetic cultivation of home lighting on the system of the Cambridge (Mass.) Electric Light Company by the use of a team of ten college-trained girls has resulted in the sale of 241 units aggregating 62,205 watts connected load in the past 2.5 months. These young women were taken from lists of experienced canvassers and survey workers and are paid a straight salary, working from 9 to 12 a.m. and evenings on five days a week. The territory is canvassed on foot, prospect lists being taken from meter cards.

The company owns about 300 "Sight Meters" and lends these to householders for about a week without charge. Three approved units are demonstrated and sold—a 28-in., 100-watt student lamp type, a 100-watt floor lamp and a unit of three lamps, 100-, 200- and 300-watts rating, floor type. The numbers sold, respectively, have been 103, 62 and 76. These units are also left on trial where necessary.

The 70 surveys arranged for by these saleswomen will be handled by the home service department.

Out of this bridge party in the Ohio Public Service power plant in Lorraine grew this model kitchen at the plant, where groups are now entertained.

Prevents bearing temperatures *from climbing to danger point*

You can't take chances on bearing temperatures. It is too risky. Also costly. Overheating not only is liable to damage the bearing but also to interrupt the continuity of service. Both must be avoided.

One hydro station of a large southern electric power company, realizes this. For this reason you will find here a Bristol's Thermometer Controller, Model 277B, installed in connection with a 100 ton thrust load Kingsbury bearing on an A.C. vertical type generating unit of 14,500 K.V.A. capacity. By sounding a 110 volt horn alarm every time the temperature of the oil in the bearing well approaches the danger point, Bristol's Controller contributes to the safety and uninterrupted service of the plant. Write for Catalogue 1204.

Bristol's Temperature Controller, Model 277B, makes and breaks electrical circuits as the temperature changes. These circuits in turn initiate corrective action, sound alarms, or give other signals.

THE BRISTOL COMPANY, WATERBURY, CONN.

Branch Offices: Akron, Birmingham, Boston, Chicago, Denver, Detroit, Los Angeles, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco. Canada: The Bristol Company of Canada, Ltd., Toronto. England: Bristol's Instrument Co., Ltd., London.

TRADE MARK

BRISTOL'S

REG. U. S. PAT. OFF.

PIONEERS IN PROCESS CONTROL SINCE 1889

MEN OF THE INDUSTRY

G. T. Shoemaker Assigned to Kansas City Utility

Guy T. Shoemaker, formerly vice-president in charge of engineering for the United Light & Power Engineering & Construction Company, Davenport, Iowa, is now with the Kansas City (Mo.) Power & Light Company as vice-president. He is assuming the duties heretofore performed by Edwin Jowett, vice-president

G. T. Shoemaker

in charge of power production, who recently retired (ELECTRICAL WORLD, September 29, 1934, page 94). Mr. Shoemaker is known throughout the utility industry for his outstanding work in the field of power plant design and construction. He has been identified with the United Light system since 1913.

Mr. Shoemaker will continue as electrical and mechanical engineer for the United Light & Power Engineering & Construction Company, but will handle the work through the Kansas City office.

•

► E. S. THOMPSON, formerly vice-president and treasurer, has been elected executive vice-president of the American Water Works & Electric Company. GILBERT W. CHAPMAN, formerly assistant treasurer, was named treasurer, and LORENZO SEMPLE, JR., was elected assistant vice-president.

► FRANK P. COX, manager of the Lynn, Mass., works of the General Electric Company since 1922, has resigned, effective September 1. Mr. Cox, who is widely known in the electric meter field, entered the service of the Thomson Electric Welding Company at Lynn in 1890 and shortly afterward took up the work of meter manufacture in the Thomson-Houston plant in West Lynn. Since that time he has been closely associated with the development of meter production. He holds several patents for improvements to meters. Mr. Cox is a fellow of the American Institute of Electrical Engineers.

► GEORGE M. ARMBRUST, assistant electrical engineer of the Commonwealth Edison Company, Chicago, has been placed in charge of the plant engineering division recently formed through the combination of the design division and field engineering division. He is assisted by W. G. Kelley, plant design engineer, and N. A. Rollins, plant installation engineer. In addition to their former duties, Mr. Kelley and Mr. Rollins now have supervision over the drafting and equipment sections and the line installation and service investigation sections, respectively. The research division becomes the research section of the plant engineering division, under the charge of M. S. Oldacre.

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H. L. Masser Assumes New Executive Duties

Harry L. Masser has been appointed vice-president and assistant general manager of the Los Angeles Gas & Electric Corporation, dropping the title of executive engineer, which he assumed in 1928 when he was promoted from the position of gas engineer. A graduate of the University of California, Mr. Masser obtained his early experience in the public utility field with the Southern Californa Gas Company and the Midwest Gas Company. After spending five years with the engineering department of the Railroad Commission of California he joined the Los

H. L. Masser

Angeles utility as gas engineer, the position he occupied until 1928, when he was made vice-president and executive engineer in charge of all production, distribution, construction and operation, both gas and electric.

F. O. Dolson New President of Pacific Coast Group

F. O. Dolson, vice-president and general manager of the Southern Sierras Power Company, Riverside, Calif., has been elected president of the Pacific Coast Electrical Association. Mr. Dolson has been prominently identified with the utility industry on the Pacific Coast for a number of years. He entered the employ

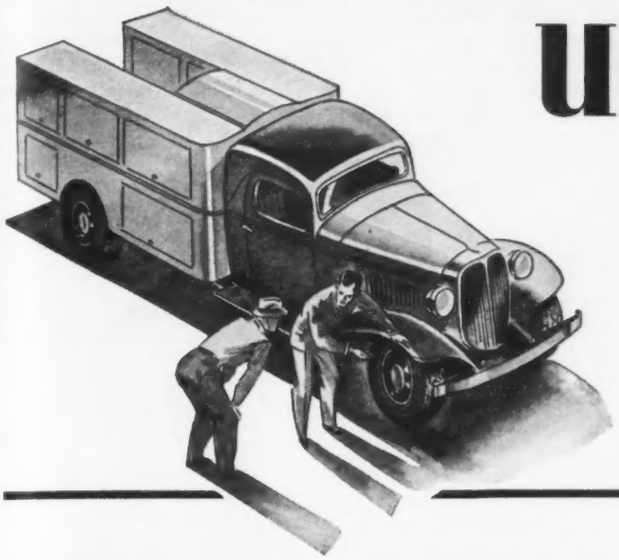
F. O. Dolson

of the Southern Sierras organization in 1914 as inspector on the construction of the Imperial Valley line and at the conclusion of that work was placed in charge of hydro plants on Bishop Creek. During 1916-17 he supervised the construction of the Rush Creek plant. In 1918 he was transferred to Riverside as general superintendent of the entire electrical system of the associated companies and four years later was elected vice-president of those companies, including the Nevada-California Power Company and the Yuma Utilities Company. His appointment as assistant general manager followed in 1922 and that of general manager subsequently.

•

► KEITH HENNEY, formerly managing editor of the McGraw-Hill publication *Electronics* and a member of the editorial staff since the inception of the magazine in April, 1930, has been appointed editor-in-chief. As associate editor and later as managing editor Mr. Henney has had the opportunity to follow closely all the developments in the radio, communication and related industrial fields during the life history of the magazine and he brings, therefore, a wealth of knowledge to his new editorial position. Before entering upon his editorial career in 1925 with *Radio Broadcast Magazine*, he was associated with the U. S. Shipping Board and

• TIRE NEWS FOR UTILITIES!



General ends use of PASSENGER CAR TIRES on light trucks—with first and only real truck tire in light delivery sizes.

PERHAPS you haven't realized it, but until recently only *passenger car tires* were available to utilities for their light trucks in city and suburban service.

If you have been troubled with beads pulling out—sidewalls breaking down—casings bruised and broken—poor mileage and short tire life—that was the reason.

And no wonder! Passenger car tires couldn't be expected to "take it" in truck work—to carry the loads—to stand the pounding punishment on rough roads—the bruising and scraping against curbs.

Now comes the General *"Special Commercial"*—the *only* tire of truck construction that is made to fit the rims on your light trucks—the *only* tire that will do a real *truck tire* job from a mileage standpoint. It has heavier beads, heavier fabric, more rubber between the plies and a much thicker tread.

Of course you want to learn more about what the "Special Commercial" can save you on *your* light trucks. You can get the facts from your General Tire dealer.

He is a practical truck tire man with wide experience and accurate knowledge in fitting the right type and size of tire to *all your trucks,* no matter what they do. He has the most complete, most highly specialized line of truck tires in the business. This combination is worth real money to you.

•

3 REASONS
WHY GENERALS ARE MORE PROFITABLE TO YOU:

1. Generals are stronger tires—additional full-width plies of powerful cord are anchored bead to bead—with no "idle" plies—no floating breaker-strips.

2. Generals are cooler tires—they flex uniformly without that heat-producing "hinging action" of ordinary breaker-strip tires.

3. Generals have "compact rubber" treads—their construction keeps the tread rubber compact and compressed so that it wears slowly and gives more miles.

★

THE GENERAL SPECIAL COMMERCIAL

is used by many utilities on a majority of their trucks. This is only one of the complete line of Generals—each designed and built specifically to do a certain job better.

★

FREE this valuable booklet on how to get more service from your truck tires. Write The General Tire & Rubber Company, Akron, O.

GENERAL TRUCK TIRES

with the Bell Telephone Laboratories. Widely known as an author in the radio field, Mr. Henney has to his credit three extensively used books, Principles of Radio, The Radio Engineers Handbook and Electron Tubes in Industry.

•

Westinghouse Elevator Names Rathbun Sales Manager

Ross Rathbun, since 1928 assistant general sales manager of the Westinghouse Electric Elevator Company, has been appointed general sales manager. Mr. Rathbun has been associated with the Westing-

Ross Rathbun

house interests since 1916, when he became identified with the Westinghouse Electric & Manufacturing Company's sales staff in Chicago. Two years later he joined the Pittsburgh sales division and in 1920 became manager of the central station section at Cleveland. Mr. Rathbun returned to Chicago in 1928 as assistant general sales manager of Westinghouse Electric Elevator Company.

•

▶ Dr. Elihu Thomson was elected an honorary president of the International Electrotechnical Commission at the recent meeting in Brussels.

▶ Norris R. Mendenhall is the new president of the Denver Electrical Contractors Association, succeeding William A. J. Guscott, who has served for the past several years.

▶ Frank A. Merrick, president of the Westinghouse Electric & Manufacturing Company, has been decorated by the Emperor Hirohito with the Order of the Rising Sun, third class, in appreciation of technical assistance rendered to Japan's electrical industry and for aid in the electrification of the government's railway lines. Communications Minister Tokonami made the presentation. Mr. Merrick left America last April for a tour of the Orient.

▶ Paul F. Williams, assistant electrical engineer of the Commonwealth Edison Company in charge of the field engineering division, engineering department, a veteran of 37 years wth the company, retired on August 1. Mr. Williams is widely known in the electric light and power industry for his contributions to the development of equipment in the field of electrical distribution. Starting with the company in 1898, he became assistant general inspector in 1904, engineer of distribution in 1921 and was appointed assistant electrical engineer in 1932. Mr. Williams has been a frequent contributor to trade and technical publications.

•

New England Power Shifts Operating Heads

A three-cornered transfer of divisional superintendents in the operating department of the New England Power Association is in process this month. Stanley W. Stoddard, in charge of the northeastern district, Lawrence, Mass., becomes central division superintendent at Worcester, Mass.; Treffly C. Capistron goes from Worcester to Providence, R. I., as superintendent of the southern division, and John W. Keeney moves from Providence to Lawrence.

Mr. Stoddard joined the New England system in 1920 and had much to do with the design and construction of many of its generating plants. With the creation of the northeastern division in 1930 he became its first operating executive. Mr. Capistron joined the New England Power Company system twenty years ago and has been in the operating department ever since, with headquarters in Rhode Island and Worcester, where he has headed the central division since 1929. Mr. Keeney entered the New England system in 1928 with headquarters at Providence, R. I., having charge of power production on the interconnected properties centering at the Rhode Island capital.

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▶ L. C. Parks, Cumberland district manager of the Tennessee Electric Power Company, Murfreesboro, Tenn., has resigned his connection to become vice-president and general manager of the Gulf Power Company, with headquarters at Pensacola, Fla.

▶ Claude D. Lawrence, assistant sales manager of the New England Power Engineering & Service Corporation since 1933, has been appointed power sales manager of the company, succeeding the late Hugo Rocktashel. He will be responsible for the activities of the power sales department in behalf of utilities affiliated with the New England Power Association. Mr. Lawrence joined the New England system as assistant to Mr. Rocktashel in 1929, becoming assistant sales manager about five years later. He formerly engaged in power sales work for the Central Hudson Gas & Electric Corporation.

H. S. Brown Assumes Foster Wheeler Presidency

Harry S. Brown, who was elected president of the Foster Wheeler Corporation (Electrical World, August 3, page 72), received his engineering degree at Cornell University and joined the Power Specialty Company in 1904. He served in its engineering and sales departments for fifteen years, becoming manager of the New England division with headquarters at Boston. In 1919 Mr. Brown resigned from Power Specialty Company to accept the position of vice-president of Wheeler Condenser & Engineering Company. In

H. S. Brown

1927 the Power Specialty Company and Wheeler Condenser & Engineering Company consolidated to form Foster Wheeler Corporation and Mr. Brown became its vice-president in charge of sales and a director.

Mr. Brown succeeds his brother, J. J. Brown, as president. J. J. Brown had held both the offices of chairman of the board and president for the past two years. He resigned as president, but continues actively as chairman of the board.

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▶ Clifford Rost has been named superintendent of the municipal light and power plant at Rockford, Iowa.

▶ R. E. Bard has been appointed manager of the dealer co-operation department of the Commonwealth Edison Company, Chicago. This department, devoted to the promotion of friendly co-operation between the company and all Chicago dealers in electrical merchandise, was formerly known as the bureau of merchandising co-operation.

▶ S. C. Mitchell, formerly advertising manager of the Leonard Refrigerator Company, has been appointed director of advertising and sales promotion for Kelvinator Corporation. Mr. Mitchell succeeds Vance C. Woodcox, who recently resigned to take an executive position with Montgomery Ward & Company. In his new position Mr. Mitchell will be in charge of advertising and sales promotion activities for all Kelvinator Corporation's

Roebling Varnished Cambric Cables are available in single, two, and three-conductor types; for a wide range of voltages; in gauges from No. 14 B. & S. to 2,000,000 circular mils.

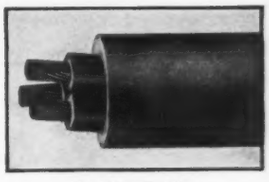
Braided or leaded. Also with steel, zinc or bronze tape, or round wire steel armor.

We would welcome your inquiry for further information and prices in connection with this type of cable or any of the 60 other types of Roebling Electrical Wires and Cables.

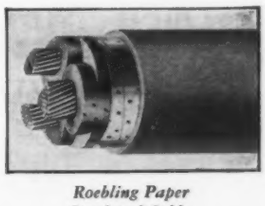
OVER 60 OTHER TYPES

Power Cables: Paper; Cambric; Rubber » Parkway Cable » Tree Wire » Service Cables » Station Cables » Rubber Covered Control Cables » Rubber Covered Wires and Cables: Code; Intermediate; 30% and 40% Performance; 35% and 40% Performite; Plain Rubber 60% Sheath Power Cable and 40% or 60% Sheath Flexible Cords » Slow Burning Wires and Cables » Weatherproof Wires and Cables » Submarine Cables » Portable Cords » And a wide variety of other wires and cables.

JOHN A. ROEBLING'S SONS COMPANY
TRENTON, N. J. *Branches in Principal Cities*

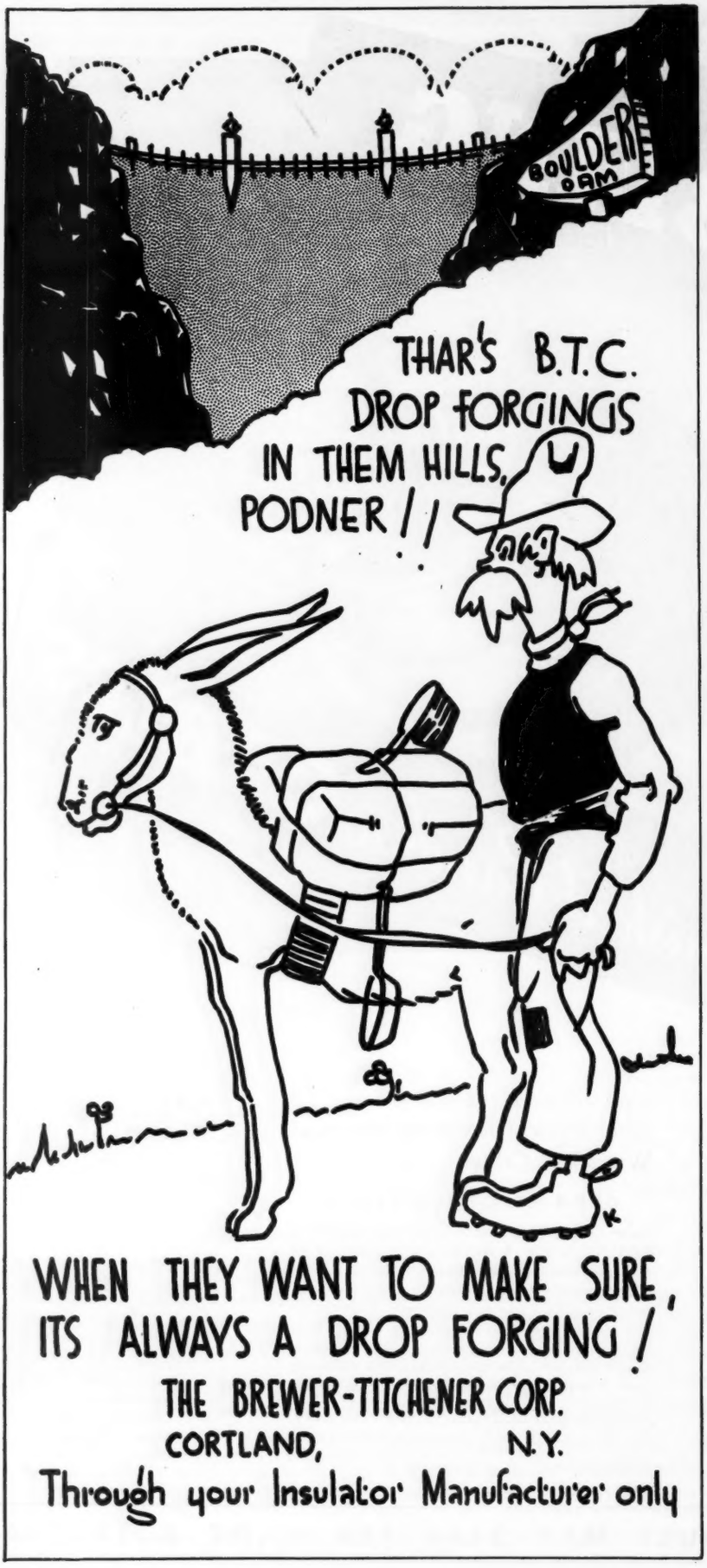


Roebling Rubber Insulated Cable.



Roebling Paper Insulated Cable.

ONLY A FINE PRODUCT MAY BEAR THE NAME ROEBLING


BOULDER DAM
THAR'S B.T.C. DROP FORGINGS IN THEM HILLS, PODNER!!
WHEN THEY WANT TO MAKE SURE, ITS ALWAYS A DROP FORGING!
THE BREWER-TITCHENER CORP.
CORTLAND, N.Y.
Through your Insulator Manufacturer only

products, including domestic and commercial refrigeration equipment, oil burners, electric ranges and air conditioning. Mr. Mitchell joined the Kelvinator organization in 1932 after considerable experience in the automobile industry.

OBITUARY

► LESLIE R. GRANT, assistant to the general sales manager of the Puget Sound Power & Light Company, with headquarters in Seattle, died in that city July 19, following an illness of two months. Mr. Grant had been connected with the Puget Sound utility since 1919. He was 55 years old.

► JAMES S. FITZMAURICE, consulting electrical and mechanical engineer, Adelaide, South Australia, died in April. For many years Mr. Fitzmaurice was a local honorary secretary of the American Institute of Electrical Engineers. He was also a member of the Institution of Electrical Engineers of Great Britain.

► CHESTER H. NORWOOD, for many years associated with the A. B. See Electric Elevator Company, died in Boston, Mass., July 27, at the age of 46. He was chief engineer at the company's New York office for about three years, and later was connected as construction engineer with the Boston office. For some time he was a partner in the engineering firm of Norwood & Ramsdell, Boston.

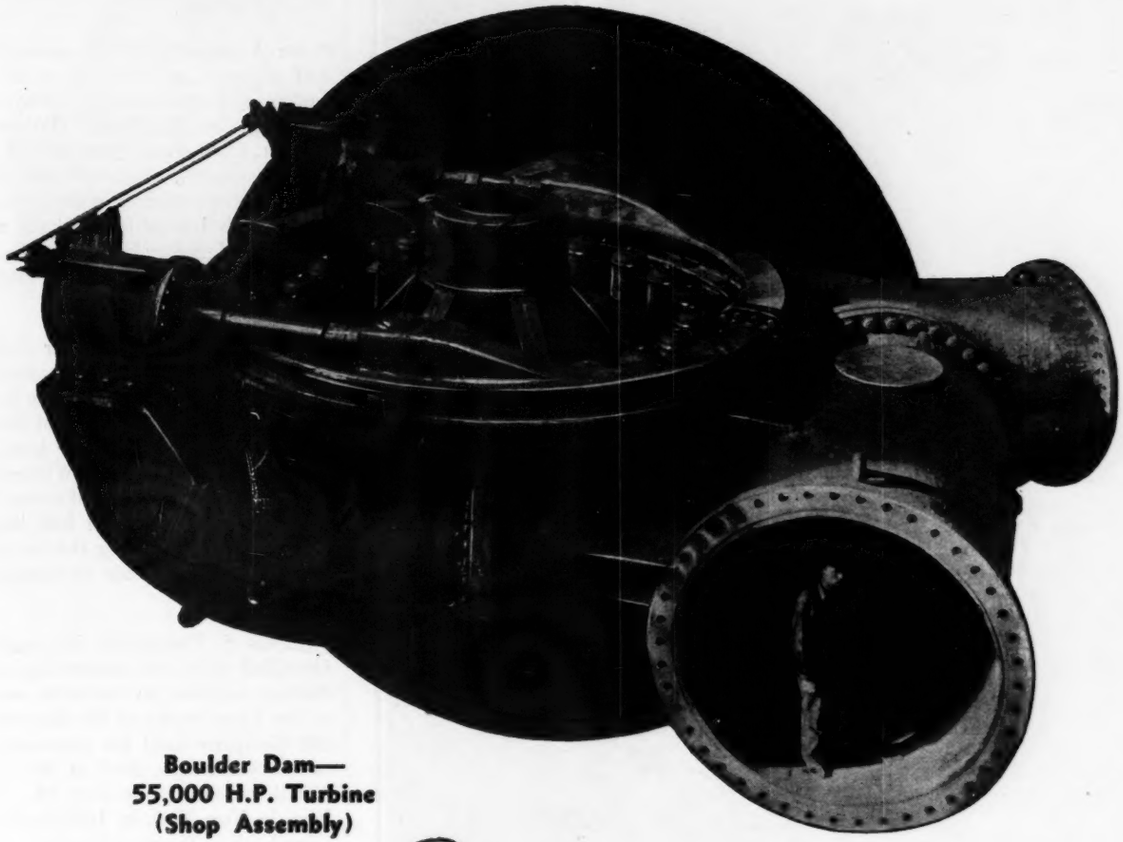
► LON ALEXANDER, a veteran member of the Duke Power Company at Charlotte, N. C., died May 24 in that city, following an acute illness of two weeks. As a young man, Mr. Alexander entered the services of the old Catawba Power Company, forerunner of the Southern Power Company and the Duke Power Company, in 1904. In 1922 he was made superintendent of the electric light and power department of the Charlotte branch of the Southern Public Utilities Company, merged this year with the Duke Power Company. He was 57 years of age.

►JOSEPH SHOWALTER, who for the past fourteen years had been sales engineer for the Canadian Westinghouse Company, Ltd., Toronto, died June 5. His early engineering training he received in the United States with the Diamond Meter Company, the Peoria Gas & Electric Company and the Duncan Electrical Manufacturing Company. Upon transferring his interests to Canada he became identified with the Western Electrical Manufacturing Company, Berlin, Ontario, and, after spending three years in electrical contracting, he became chief engineer for Ferranti Electrical Company, Ltd., the Canadian branch of

HYDRAULIC TURBINES

FRANCIS AND PROPELLER TYPES

AND ACCESSORY EQUIPMENT



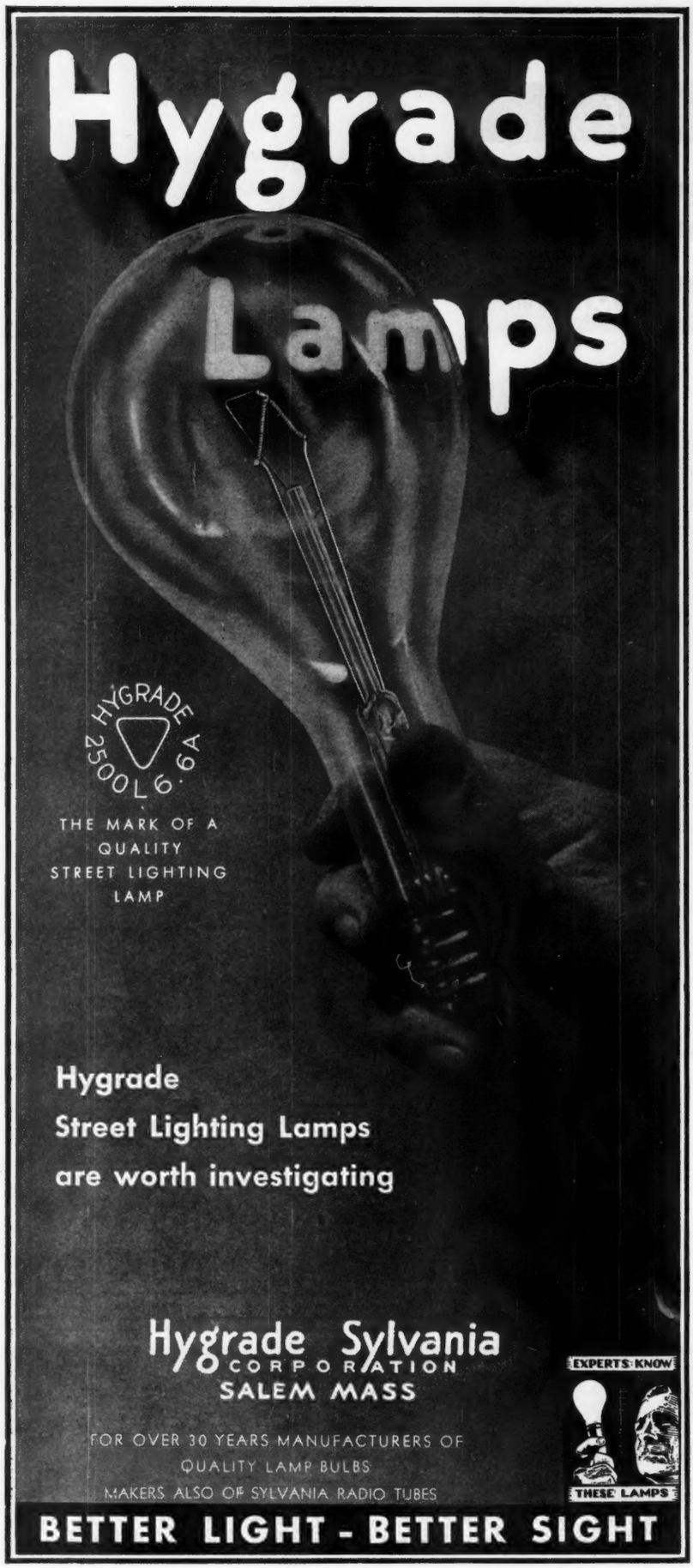
Boulder Dam—
55,000 H.P. Turbine
(Shop Assembly)

Write for our latest catalog

"WATER POWER EQUIPMENT"

NEWPORT NEWS
SHIPBUILDING AND DRY DOCK COMPANY
HYDRAULIC TURBINE DIVISION

NEWPORT NEWS, VA. 90 BROAD ST., NEW YORK, N. Y.



Ferranti, Ltd., of England. In 1920 he left the Ferranti company to undertake practice as an electrical engineer and shortly thereafter became sales engineer of the Toronto office of the Canadian Westinghouse company. He was 55 years of age.

▶ JOHN J. HOWARD, electrical engineer the Connecticut Company, New Haven, died June 3. Mr. Howard had been associated with the Connecticut Company since 1911. In 1917 he became electrical engineer for the company, in charge of electrical design and construction. Previously he was connected with the Allis-Chalmers Company. He was 55 years of age.

▶ DR. ARTHUR D. LITTLE, renowned chemical engineer and president of the organization at Boston bearing his name, died suddenly at Northeast Harbor, Me., August 1. He was often identified with investigations for electrical industry interests and was a pioneer in the development of research laboratory methods adapted to modern large-scale business as well as in the application of scientific methods to smaller undertakings.

▶ ALBERT B. PAGE, a member of the General Electric Research Laboratory since 1916, died August 6 at his home in Schenectady, after several months of illness. In recent years Mr. Page had been an assistant to Dr. Willis R. Whitney, vice-president and formerly director of the research laboratory, and had been specially active in studying the use of high-frequency currents for therapeutic purposes.

▶ LEWIS S. URQUHART, for many years identified with cost accounting and production activities in executive capacities at the Lynn works of the General Electric Company until his retirement about twelve years ago, died at his home in Middleton, Mass., on July 23. He was born in New York in 1859, and in 1886 joined the Thomson-Houston Electric Company at Lynn.

▶ RUFUS E. LEE, for a number of years engaged in the promotion and operation of power plants and transmission lines in Nebraska and Iowa, died August 3 at his Omaha home, following a heart attack. He was 61 years old. His first ventures were plants in Superior, Neb., and Clarinda, Iowa, and within a few years he was head of the Continental Gas & Electric Company, owning plants in Nebraska, Iowa, Kansas and Missouri. He retired from the presidency of the company after the sale in 1925 of his properties, in the ownership of which he was interested with the Cyrus Eaton syndicate, to the United Light & Power Company. Since then he had been operating the Rufus E. Lee Investment Company, dealing in power securities.

Meet
ED CROFTS,

Supt., Rochester Gas & Electric Co.

LIKE most utility executives, Ed Crofts has many responsibilities—he's a busy man. Here's what he did in a typical day's work:

Arrived at office at 8:30 A.M. . . . Took care of mail. . . . Signed requisitions authorizing routine purchase of materials and supplies. . . . Discussed plans regarding plant and line installations with J. A. Fredericks, Ivan Powell, and C. G. Durfee, engineers and superintendents. . . . Jack Brown, local merchant, called regarding a special form of service desired.

Had lunch with Sam Thompson, Bill Carson and Jack Wilson, city officials, to discuss possibility of improving street lighting along outlying boulevards. . . . Representatives of three electrical manufacturers called to point out advantages of different types of new equipment. . . . Had meeting with foremen of steam and hydro generating plants to consider improvements. . . . Plus many miscellaneous and routine duties.

• *He confers with Electrical World, too*

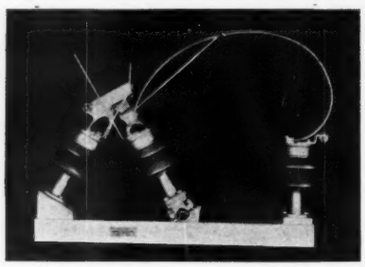
ED CROFTS is never too busy to read Electrical World. In his own words, he finds "the advertising pages almost as interesting as the editorials and one of the most effective means of keeping in touch with advances in the industry."

There are thousands of "Ed Crofts" who are constantly conferring with Electrical World. It is their "bible"—has been for over 60 years.

NEW EQUIPMENT

Gang-Operated Switches

Blades of these group-operated, air-break, rural line switches are equipped with an auxiliary motion providing the leverage necessary to shatter ice formations on the



Type R.F.—38 for 7.5 and 34.5 kv. service. Base member between poles may be either steel or creosoted wood. **Delta-Star Electric Co.,** Chicago, Ill.

contacts. All metal parts on the high-potential side of the insulators are non-ferrous. Rocking the center insulator post opens and closes the switch.

•

Calculator for Meter Testing

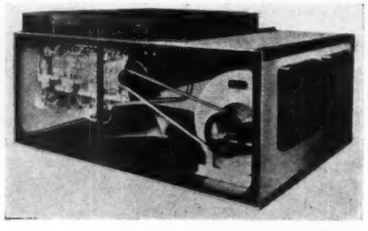
Three types available, depending upon make, number, size of coils and constant of the rotating standard used. **Herman D. Steel Co.,** Philadelphia, Pa.

Used in making tests on watt-hour meters, this pocket-size calculator gives complete information on all sizes of each type meter in one setting. No figuring is necessary as a percentage registration table gives the error of the meter under test, directly.

•

Suspended Air Conditioner

Designed for ceiling or recessed mounting and having capacities sufficient to cool two small rooms or a small store, these units are



Four types available in this size. **Kelvinator Corp.,** Detroit, Mich.

said to meet the need for modern air conditioning in the home or small business place. Units are supplied with automatic temperature control.

•

Weatherproof Meter Box

Available with two- or four-position test block. **Detroit Electric Furnace Co.,** Detroit, Mich.

Long service under severe weather conditions, ease of installation and positive protection against current theft are features of this meter box. The body of the box is of galvanized sheet steel protected with a coating of baked aluminum paint. The removable cover is provided with a heavy glass window to facilitate meter reading.

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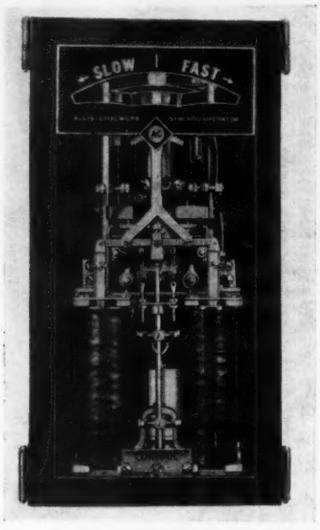
Synchronizing Device

This device provides an accurate and safe means of automatically paralleling any a.c. generator which has a prime mover the speed of which can be varied by electrical



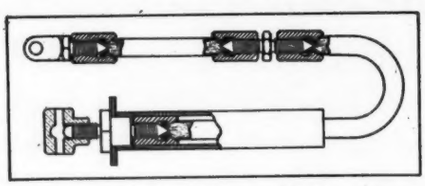
Several units can be synchronized from one instrument; can be mounted on individual panel or on swinging bracket; dimensions 7x7x13¼ in. **Allis-Chalmers Manufacturing Co.,** Milwaukee, Wis.

control. It performs automatically the combined functions of speed matching, synchronizing and visual phase-angle indicating. Automatic synchronizing contacts are provided for closing the breaker at the instant of synchronism. Auxiliary relays handle the control currents of the breakers and governor and also provide positive interlocks, preventing faulty operation. This "Synchro-Operator" operates through existing potential transformer metering circuits and requires no special features on prime mover or governor.

•

Welding Electrode Holder

Poor contacts along the path from welding generator to electrode are said to be eliminated by the novel construction of this

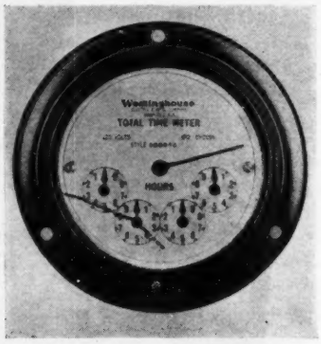


Navy type holder. **Metalweld, Inc.,** Philadelphia, Pa.

electrode holder, which provides positive, vice-like contact; eliminates springs, levers and soldered joints; keeps the handle from heating and permits the welder completely to control the electrode at all times. Rapid change of electrodes is said to be possible.

Total Time Meter

Total running or idle time of electrically operated machinery such as machine tools, welders, signs, refrigerators, radio transmit-



Available for 11, 120, and 240 volt operation; consumes 1.5 to 3 watts, depending on voltage. **Westinghouse Electric & Manufacturing Co.,** East Pittsburgh, Pa.

ters or any individual a.c. powered unit can be obtained with this total time indicator. The meter consists essentially of a register and synchronous motor mounted in one case. It will measure time up to 9,999 hours without repeating.

•

Carbon Resistors

Rating ¼ to 10 watts; "Ohiohm LV" series. **Ohio Carbon Co.,** Lakewood, Ohio.

Satisfactory operation under severe humidity conditions is claimed for these carbon resistors. Resistances as low as 0.04 ohm are obtainable.

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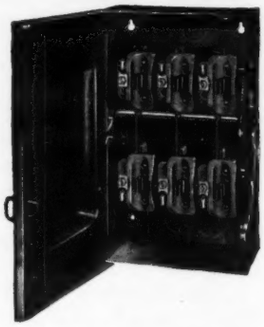
Industrial Safety Switches

Arcing is reduced in these revised industrial safety switches by means of a "Quad-break" switching mechanism which provides



Colt-Noark, type A, 575 volt. A 250-volt size with "Dual-break" switching available. **Colt Patent Fire Arms Manufacturing Co.,** Hartford, Conn.

four current rupture points in each circuit leg. Unit blocks permit removal of a complete block for cleaning and adjusting without disturbing the rest of the switch. Line and load connections can be made at either top or bottom of the switch.

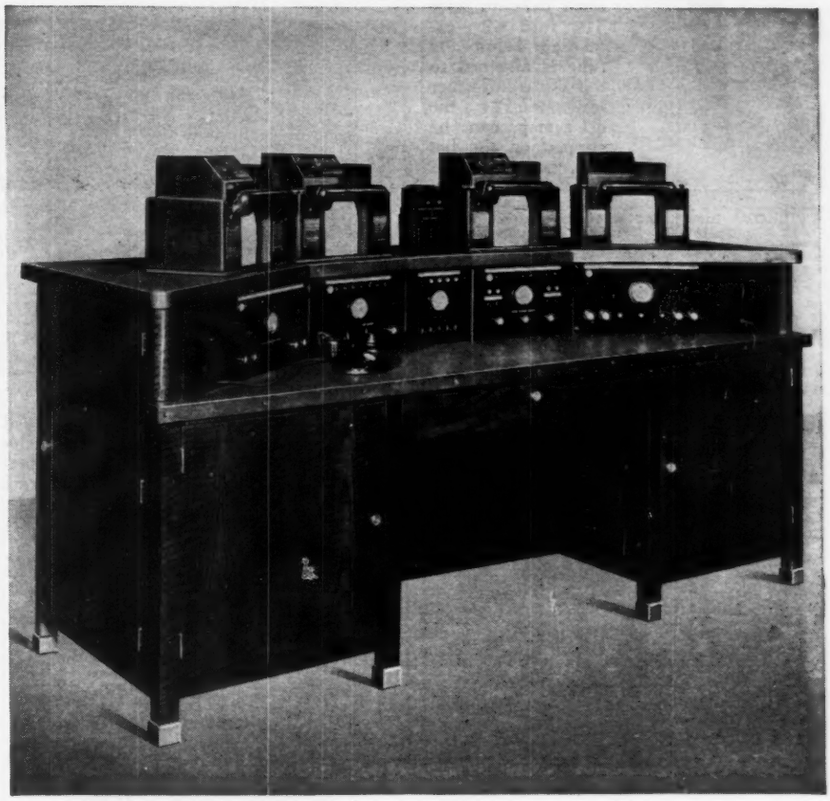
★

Safeguarding Property

Worth Billions of Dollars...

PROTECTIVE signaling and supervisory systems made by The Autocall Company are safeguarding the properties of Public Utilities, Industrial Corporations and Mercantile Organizations. Each installation is engineered for the particular service it will be called upon to render. All installations, however, must be dependable to the last degree.

As these protective systems are electrically operated the character of the insulation used is of the utmost importance. Because of this, Bakelite Materials are extensively used. Bakelite Laminated for the panels of the operators desk, and



Bakelite Molded for a variety of insulation parts, including those exposed outdoors to climatic and atmospheric conditions.

Of these materials The Autocall Company write:—"From an engineering and installation standpoint, no other class of material could offer us the permanence, reliability and beauty of Bakelite Materials... It would not seem that Bakelite Materials could be called upon to perform any greater duty than that of taking part as a silent watchman guarding billions of dollars worth of property."

Engineers and manufacturers are invited to consult our technical staff about the use of Bakelite Materials in electrical apparatus and appliances, and also to write for copies of our illustrated booklets 3L "Bakelite Laminated" and 3M "Bakelite Molded".

Photos show Autocall operators desk at Port Authority Building, New York. Panels of Bakelite Laminated, Summary Indicator and other parts of Bakelite Molded.

BAKELITE CORPORATION, 247 Park Avenue, New York, N. Y. . . . . 43 East Ohio Street, Chicago, Ill.
BAKELITE CORPORATION OF CANADA, LIMITED, 163 Dufferin Street, Toronto, Ontario, Canada

BAKELITE

The registered trade marks shown above distinguish materials manufactured by Bakelite Corporation. Under the symbol "B" is the numerical sign for infinity, or unlimited quantity. It symbolizes the infinite number of present and future uses of Bakelite Corporation's products.

THE MATERIAL OF A THOUSAND USES

Disconnecting Fuse

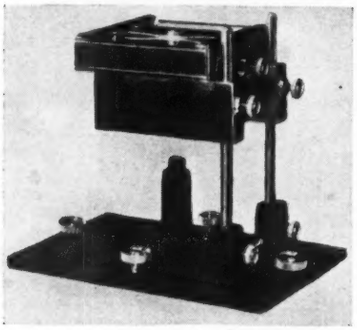
Designed to provide inexpensive fuse protection for the new single-bushing, grounded-neutral transformers now frequently used on low revenue, single-phase, rural lines without protection, these line clamp disconnecting fuses consist of a standard line clamp attached to a fiber-lined bakelite tube. The fuse wire extending below the tube is attached to the transformer lead while the clamp can be slipped on the hot line and tightened with a switch stick.

"LKOT" fuses; one size for systems to 12,500 volts Y. **Railway & Industrial Engineering Co., Greensburg, Pa.**

•

X-Ray Viewing Device

Used for the high-speed, high voltage, X-ray defraction analysis of metals, to study the effects of mechanical working, heat treatment, extrusion and to determine internal strain, this instrument mounts directly on radiographic X-ray equipment and may be used simultaneously while inspecting castings. Entire sheets of formed articles can be mounted in the instrument.

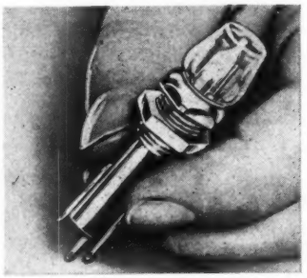


Used to examine tin, brass, steel and other metals. **St. John X-Ray Service,** Long Island City, New York.

•

Indicator Tattletales

This line of tiny neon pilot lights tell when motors, heaters, electric clocks or radios are operating, being installed either in the power or remote-control circuits. Conversely, they can be made to indicate open circuits. A limiting resistance is built into its octagon-shaped base.



The lamps draw 0.001 amp. and have 3,000 hours life; used on 90 to 250-volt circuits, a.c. or d.c. **Littlefuse Laboratories, Chicago,** Ill.

•

Starter for Small Motors

Adaptable to almost any fractional-horsepower application, this motor starter provides protection against overloads with a free-tripping thermal overload mechanism. Overloads are indicated by return of the operating button to the off position. Pushing the start button resets the overload mechanism and restarts the motor. Capacity of the starter can be varied to provide protection to different size motors by changing the heater coil.

Bulletin 9101. **Cutler-Hammer, Inc.,** Milwaukee, Wis.

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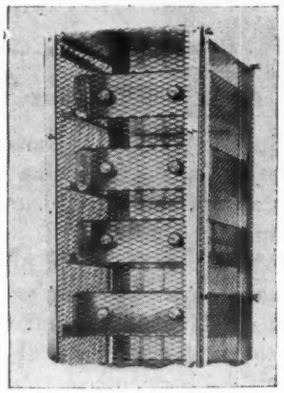
Rack-Type Capacitors

For either indoor or outdoor installation, these capacitor units for power-factor correction consist of a number of box-type capacitors mounted on an angle-iron framework. Both small and heavy duty units are available.

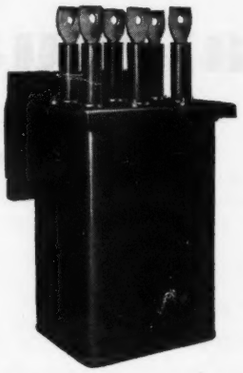


Small units—Capacities 30 to 240 kva. at 230 to 4,600 volts. Heavy duty—Capacities up to 1,200 kva. at voltages from 230 to 6,600. **Conrad-Dubilier Corp.,** Bronx, N. Y.

•

Small Oil-Blast Breaker

Particularly applicable where space is limited, this breaker features compact construction, silver-to-silver main contacts protected by arcing contacts, oil-blast baffles, "Herkolite" bushings and entire absence of external moving parts. All designs are double and triple pole, single throw. Accessories available include overcurrent trip coils, undervoltage devices and auxiliary switches.



Rating: 600 amp., 7,500 volts; 800 amp., 2,500 volts; interrupting capacity, 25,000 kva.; Type FK-42. **General Electric Co.,** Schenectady, N. Y.

ENGINEERING DATA FROM MANUFACTURERS

Bulletins and catalogs now available to engineers by manufacturers and associations

"Direct-Current Generators" is the title of bulletin 1171 of the Allis-Chalmers Company, Milwaukee, Wis., which outlines, in 12 pages, the design and construction features of d.c. generators for central station, industrial and marine service. Several pages are devoted to description with wiring diagrams of "frog-leg" armature winding used in these machines.

Tenth edition catalogue of New Departure ball bearings is now available by writing the New Departure Manufacturing Company, Bristol, Conn. This catalogue (144 pages), contains tolerances and mounting fits for bearings, bearing closure data and information on methods of bearing selection.

"Mercury-Arc Power Rectifiers," a 12-page Allis-Chalmers bulletin marked No. 1169, describes the construction and operation of this type of equipment. Sectional drawings and wiring diagrams are used to illustrate operation and application.

General Electric Company bulletin GEA-2050 (8 pages) presents design and construction features, rating data and dimensions of its new type FK-43 oil-blast circuit breaker.

A complete discussion of the theory and operation of crystal valve lighting arresters used for protecting distribution transformers is given in a recently announced 90-page catalogue (No. 381) of the Electric Service Supplies Company, Seventeenth and Cambria Streets, Philadelphia. The text is amply illustrated with wiring diagrams, characteristic curves and oscillograms.

Catalogue 7502-D, a 32-page illustrated booklet, describes with the aid of specification tables and sectional views the construction features and application of type-30 industrial compressors and vacuum pumps made by Ingersoll-Rand, 11 Broadway, New York.

"Unit Substations," a 33-page book (GEA-2078) announced by the General Electric Company, describes and illustrates typical installations of small factory-built unit substations for distribution systems. A chapter is devoted to primary network operating problems.

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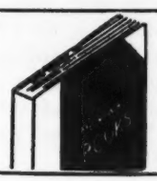

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Mr. and Mrs. Smith Do Some Figuring

[*Continued from page 57*]

couple of old flywheels, the door off of one of the elevators in the company's office building, and the assistant treasurer's brass spittoon."

"What good would all that junk do us?" inquired Mrs. Smith, looking puzzled.

"No good at all! That's just what I'm saying," responded Mr. Smith with some heat. "They talk about 'share-the-wealth,' but when you go to figure out just how you'd go about sharing it you begin to see that there isn't much sense in it. The minute you start dividing up the biggest and most necessary public utility in town, that very minute you make it as useless to everybody as a powder puff to a Berkshire sow. What use would a lot of loose flywheels, pieces of dynamo, hunks of transformer and reels of copper wire be to anybody, if they couldn't get any 'juice'?"

"No use," agreed Mrs. Smith amiably. "So far as electricity goes it looks to me as though we've got a 'share-the-wealth' scheme in effect in this country right now, and the thing to do is not bust it up, but keep an eye on it, and see that it does what it is supposed to do. So, if I were you I wouldn't worry any more about it, and anyway, it's time to get started if we're going to see that movie."

If Mr. and Mrs. Smith had wanted to carry this interesting conversation farther, they could have seen even stronger "share-the-wealth" implications in the existing power systems of the country; in the fact that their securities are distributed among insurance companies, banks, investment trusts, endowment trusts and millions of individual investors; in the fact that $240,000,000 of the electric power revenues went for public taxes in 1934; in the fact that the business is not conducted by one big system or "trust," as some advocates try to make it appear, but by 3,600 completely separated and totally unrelated power and light companies, as the Smiths would have discovered in their trip around the country. They would have been justified in concluding that, as it is conducted at the present time, the power and light industry in the United States is probably the outstanding exponent in the land of a practicable share-the-wealth theory. And Mr. and Mrs. Brown would have been justified in agreeing with them.

Municipal Items

PHOENIX, ARIZ.—Arizona Utility Service Patrons League has been organized with headquarters in Phoenix. Plans have been made to cooperate with various organizations in an effort to bring power from Boulder Dam into the state. Particularly will the association work with the committee named recently by Governor Moeur to make a survey and obtain data for an application to the P.W.A. for funds to build a power line across the state.

PUEBLO, COLO.—By a vote of more than two to one citizens have granted a 25-year renewal of the electric franchise to the Southern Colorado Power Company.

LA SALLE, ILL.—Voters have approved a proposal to issue $750,000 revenue bonds to finance erection of municipal light and power plant. Franchise of Illinois Power & Light Corporation expired about two years ago and was not renewed.

HOPKINTON, IOWA — Voters have sanctioned proposals for construction of municipal light and power plant to be built under terms of the Simmer law at a cost of $67,800. Iowa Electric Company now serves city.

ROCK VALLEY, IOWA—Iowa Public Service Company was given a heavy majority in the vote on a twenty-year franchise to supply town with energy.

VALISCA, IOWA — Iowa-Nebraska Light & Power Company has asked the Supreme Court to rehear its suit against the city and the Electric Equipment Company, Des Moines, Iowa. The high court recently ruled that a contract between the city and the equipment company for construction of a municipal power plant at an estimated cost of $148,850 was valid (ELECTRICAL WORLD, July 6, page 89). The Iowa-Nebraska utility has petitioned for a rehearing on a similar suit against the city of Corning, Iowa, and the Fairbanks, Morse Company.

ST. PAUL, NEB.—Plant of the Central Power Company has been purchased by the city. City officials sold $42,000 worth of bonds to cover the cost of the transaction.

MCCOOK, NEB.—Overruling protests of the Nebraska Light & Power Company, which serves the town, State Engineer A. C. Tailley authorized the organization of a municipally owned power district. McCook is the home of Senator George W. Norris. Negotiations for the purchase of Nebraska Light & Power's plant will start soon. The district has been granted permission to purchase the plant or build one of its own, or buy power from the Platte Valley public power and irrigation district or some other power project and distribute the energy in McCook. At a recent hearing before the state engineer, the power company valued its investment at $650,000.

NEBRASKA—Iowa-Nebraska Light & Power Company, Southern Nebraska Power Company and Western Public Service Company have joined in formal protests against approval of the proposed $7,325,718 southern Nebraska rural public power district.

ALBANY, N. Y.—Court of Appeals, which on July 13 heard arguments on the constitutionality of the law permitting the county to establish its own power plant, adjourned to September 9 without handing down a decision in the case. The delay will not interfere with a referendum in November in the event the court upholds the statute. The deadline for notice of the referendum is six weeks before election day.

WISCONSIN—Legislation proposing that the state be permitted to enter the power business and that municipalities be authorized to compete with privately owned utilities was recently defeated by the Senate.

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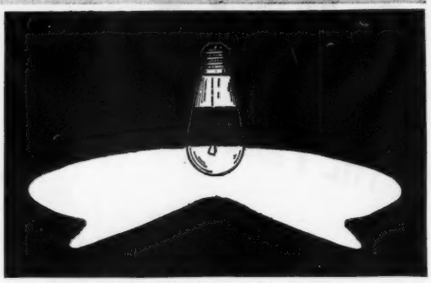

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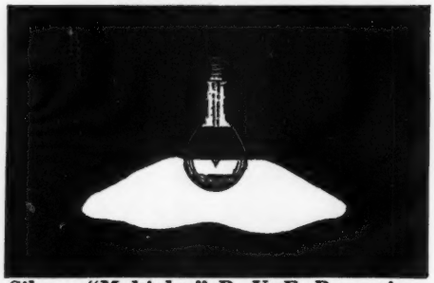

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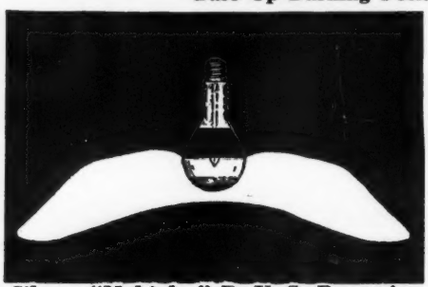

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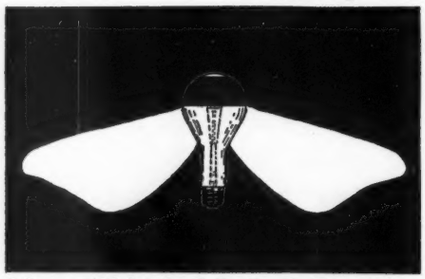

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Recent Rate Changes

Philadelphia Electric Company has filed with the Public Service Commission reductions in household electric rates affecting substantially all domestic customers in the city and suburbs. The new rates are effective September 1. The changes will yield savings of $1,500,000 a year to household consumers, according to William H. Taylor, president. Monthly savings to individual householders will range from a few cents to substantial sums, with the greatest savings accruing to those who use the most electrical appliances. Householders in Philadelphia who use only 10 kw.-hr. per month will save nothing, but those using from 50 to 125 kw.-hr. will save 20 cents per month. Mr. Taylor pointed out that the new schedule reaches a 2-cent-per-kilowatt-hour rate at 125 kw.-hr. At present the lowest rate is 2½ cents at 200 kw.-hr.

•

Pennsylvania Power & Light Company's rate structure will be investigated by the Public Service Commission, according to an order issued by the commission last week. Ending informal negotiations that have been in progress for months, the commission directed the company to show why it should not comply with requirements of the uniform accounting system and why penalties for failure to do so in the past should not be imposed. A statement issued from Governor Earle's office said studies by commission engineers and auditors showed an excess valuation of $93,000,000. The Governor requested the commission to institute proceedings when negotiations with the company failed.

•

Puget Sound Power & Light Company has cut its rates $208,160 a year outside the city limits of Seattle, effective August 1, according to a statement issued by Frank McLaughlin, president. Mr. McLaughlin's announcement was in compliance with a surprise move of the State Department of Public Service, ordering the rate cut and a graduated 10 per cent increase in wages to all company employees except executive officers. The order will suspend the department's two-year investigation of the company, instituted as one of the state's major power probes. The company will also pay the public service department $100,000 as the cost of its investigation, Mr. McLaughlin stated. The rate schedules ordered by the state department change the present farm rate from 5½ cents for the first 40-kw.-hr., 3 cents for the next 110 kw.-hr. and 2 cents for all other power, to 5 cents for the first 40, 3 cents for the next 100, 2 cents for the next 100 and 1 cent for all over 240 kw.-hr.

•

New York Power & Light Corporation has filed for approval with the state Public Service Commission new rates bringing further savings of $203,000 a year to Albany electric customers. The new rates cover all classes of electric service, commercial and industrial as well as residential. Household users of electricity will get savings totaling $102,000 a year and annual savings to commercial and industrial users will be $101,000. Otto Snyder, president of the company, pointed out that this was the second reduction in the rate for residence service made this year.

•

Alabama Power Company has been authorized by the state Public Service Commission to revise its suburban electric rates. Revised rates will result in an annual saving to customers of $28,500.

SALES OPPORTUNITIES IN NEW CONSTRUCTION

CHARLOTTE, N. C.—Duke Power Company plans rural electrification system in different parts of State, totaling about 445 miles. Permission has been secured for initial section of 127 miles, and work will begin soon, to include transmission lines, power substation and switching station facilities, distributing lines, service connections, etc. Entire project reported to cost over $1,000,000.

GRANITE CITY, ILL.—Granite City Steel Company plans installation of heavy-duty motors and controls, regulators, conveyors, cranes and other equipment in new hot strip mill and cold reducing mill. Cost about $4,500,000. Financing is being arranged.

TAMPA, FLA.—American Can Company, New York, N. Y., plans installation of motors and controls, transformer equipment, electric hoists, conveyors, etc., in new multi-unit plant at Tampa, where tract of about 20 acres of land has been purchased. Cost close to $250,000.

LODI, CALIF.—Has called special election on September 12 to approve bond issue of $466,000 for proposed city-owned hydro-electric power plant on Mokelumne River, about 27 miles from city, estimated to cost $600,000, remainder of fund to be secured through Federal grant. Initial plant will comprise a 1,374-kva. generator unit, reaction type waterwheels and auxiliary equipment; transmission line will be built to municipality, where power substation and distribution facilities will be installed. F. C. Herman and Walter L. Huber, San Francisco, are consulting engineers.

PHILADELPHIA, PA. — Supply Officer, Naval Aircraft Factory, Navy Yard, will receive bids until August 20 for 147,300 ft. low-tension electric cable and 50,000 ft. high-tension ignition cable (Aero Requisition 611).

SPARTANBURG, S. C.—Plans city-owned hydroelectric power plant on Pacolet River, with transmission line to municipality, power substation and electrical distribution facilities. Cost about $1,000,000. Financing is being carried out through federal aid.

INDIANAPOLIS, IND. — Allison Engineering Company, a division of General Motors Corporation, New York, N. Y., plans installation of motors and controls, regulators, conveyors, electric hoists and other equipment in new additions to aircraft motor-manufacturing works. Cost close to $500,000.

BRAINERD, MINN.—Plans construction of transmission lines to Nisswa, Hubert, Round and vicinity, for electric light and power service, from city-owned station, power to be secured at wholesale from Minnesota Power & Light Company. Cost about $50,000.

DENVER, COLO.—Bureau of Reclamation will receive bids for following equipment for Boulder power plant, Boulder Canyon Project, Arizona-California-Nevada: Until August 22, for two power distribution and control cabinets for downstream tunnel plugs (Specification 709-D); until August 23, for one relay board for 287.5-kva. switchyard (Specification 710-D); until August 26, for trash-rack lifting frame, two bulkhead gate-lifting frames, and installation equipment for cylinder gate hoist stems and stem guides in intake towers (Specification 711-D); until September 9, for two 82,500-kva. vertical shaft a.c. generators, with accessories (Specification 638); until September 9, for two vertical shaft 115,000-hp. hydraulic turbines, and two governors with pumping equipment for regulating speed of turbine units (Specification 639).

CLEVELAND, MISS. — Plans extensions and improvements in city-owned electric light and power plant, including installation of new equipment. Fund of $350,000 is being secured through federal aid for this and waterworks construction.

PHILADELPHIA, PA. — Commanding Officer, Navy Yard, plans installation of motors and controls, electric hoists, conveyors, cranes and other equipment in proposed new heavy machinery storage and distributing building at local yard. Appropriation of $600,000 is being arranged for project.

CLEVELAND, OHIO—Cleveland Electric Illuminating Company has filed plans for new power substation in Shaker Heights district, for booster service. Cost close to $75,000, with equipment.

MUSCATINE, IOWA — Is considering special election to approve construction of city-owned hydroelectric generating plant on Cedar River, including transmission line to city, power substation and switching facilities, and electrical distribution lines. Estimated cost $3,500,000. Financing will be carried out through federal aid.

EVANSVILLE, IND. — Briggs Manufacturing Company, Detroit, Mich., plans installation of motors and controls, conveyors, electric hoists and other equipment in new automobile body manufacturing plant at Evansville. Cost close to $170,000.

WASHINGTON, D. C.—Bureau of Supplies and Accounts, Navy Department, asks bids until August 20, for 25,000 ft. arc-welding insulated electric cable for Philadelphia, Pa., Navy Yard (Schedule 5732); until August 27 for 14 transformers for Portsmouth, Groton and Mare Island yards (Schedule 5726); at last noted time, for ten motor-generator sets, ten control panels and spare parts for Portsmouth and Mare Island yards (Schedule 5727).

SANFORD, N. C. — Contemplates city-owned electric light and power plant, and will have surveys made by committee, headed by Paul Lucas. Cost about $200,000, including distributing lines.

HOMESTEAD, PA.—Carnegie Steel Company, Pittsburgh, Pa., plans installation of heavy-duty motors and controls, motor-generator sets, regulators, electric cranes and hoists, conveyors and other equipment in new mill unit at Homestead Works for production of standard and special steel plates. Cost over $5,000.000. Company is a subsidiary of United States Steel Corporation. New York, N. Y.

GREENWOOD, S. C.—Greenwood County Finance Board has plans for construction of about 100 miles of rural electric lines in different parts of county, including transmission and distributing systems, with power substation and service facilities. Fund of $130.000 is being secured through South Carolina Rural Electrification Authority.

HUMBOLDT, NEV.—Bureau of Reclamation, Denver, Colo., will receive bids until August 28 for five power-driven, double-drum, radial gate hoists, with one portable gasoline engine-driven unit, and four 3½ x 3½-ft. high-pressure gates, together with frames, hoists, semi-automatic gate hangers, hydraulic gate hangers, conduits, etc., for spillway and outlet works, Rye Patch Dam, Humboldt Project, Nev. (Specification 713-D).

VALATIE, N. Y.—Plans municipal electric light and power plant, and electrical distributing lines. Appropriation of $109,000 has been secured through federal aid for this and a warehouse building.

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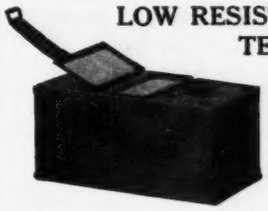

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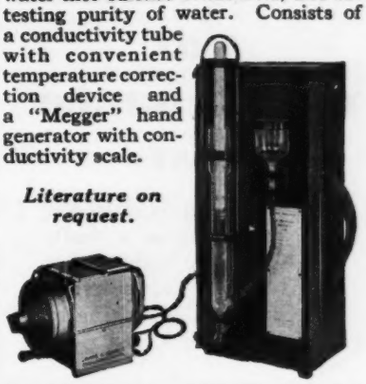

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Lincoln Demand Meters have truly simplified the measurement of maximum demand. They contain no complicated mechanisms nor rapidly moving parts. They operate as simply as an ordinary deflection type indicating meter.

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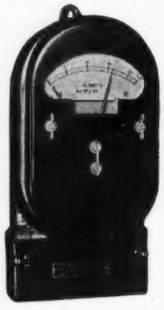

Polyphase meters to meet every need

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Cut maintenance cost

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